A STUDY TO IMPROVE THE BRAZILIAN AIR FORCE'S MATERIAL MANAGEMENT SYSTEM

THESIS

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THESIS

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Preface

The system used by the Brazilian Air Force to control its inventory of aeronautical material, named Project 300, has suffered, since its introduction, numerous criticisms. Actually it has some weaknesses, however qualities and potential capabilities, not entirely explored yet, are also present in the system, and could be useful to improve its performance. The need to write a thesis as a requirement of the AFIT graduate program, together with our desire to contribute with some suggestions to improve the Project 300, led to the development of this study, that, we hope, will be of some utility for the evolution of the Brazilian Air Force's material management system.

Our sincere thanks to our friends from the Brazilian Air Force, whose collaboration, by promptly sending all the data we needed, was invaluable to the conclusion of this work. Our thanks to our thesis advisor, Dr. Craig Brandt, whose patient guidance was decisive to the accomplishment of this study.

Finally, we wish to stress our gratefulness to our wives, Rita and Gloria, for their support and understanding during the period of intense work dedicated to this thesis.

Nelson R. Farias　　　　　　　　Pedro R. Boareto

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Abstract

The first objective of this study was to identify all the common supply items currently being managed separately in the inventory of the various types of aircraft employed by the Brazilian Air Force, and to show how the system could be reorganized to consider the compatibility among these items. DBASE III programs were used to examine a file with 30103 registers containing part numbers occurring more than once in different aircraft's inventory, and to classify them in groups of identical items likely to be centrally managed. In addition, it was demonstrated that the system's structure would support the proposed reorganization without deep changes.

The second issue in this thesis was the appropriateness of creating a system based on the dependent demand concept, that would enable the Brazilian Air Force's depots to predict the consumable items necessary to carry out their maintenance tasks with more accuracy. A conceptual program in QUATTRO PRO, which uses basic principles that would apply in the development of such a system, was written to show that the information necessary to create the proposed system is already available, and to show its usefulness for the depots.

A STUDY TO IMPROVE THE BRAZILIAN AIR FORCE'S MATERIAL MANAGEMENT SYSTEM

I. Introduction

The Brazilian Air Force's Inventory Control System

Up to 1964, the Brazilian Air Force (BAF) used a completely manual system to control its inventory of aeronautical material. It required huge files composed of thousands of cards at the warehouses, one card for each item in stock. Whenever an item's situation was altered due to shipment being received or sent out, it had to be manually updated on the corresponding card. Stock replenishment demanded reviewing the entire file to detect every item that had reached the reorder point. In general the process of stock control through this system was very laborious and time consuming. Modernization was needed and it began on August 31, 1964 with the purchase by the Brazilian Government of the first five Lockheed C-130E aircraft (1:IV). Besides the purchase of the airplanes themselves, the contract between

the Brazilian Air Force and Lockheed contained clauses involving supply, maintenance, and technical assistance. One of them established that the supply control for the C-130 would be based on a mechanized system developed by Lockheed named "Project 300", which was bought by the Brazilian Government together with the airplanes (1:IV). Since then, the Project 300 suffered a lot of adjustments to fit the Brazilian Air Force's peculiarities, and its use was expanded. In 1966 it was already being used to control the inventory of four other aircraft besides the C-130. Finally, in 1967, a decision was made to extend the employment of the Project 300 to control the inventory of all types of aircraft in the Brazilian Air Force (1:IV).

The advent of the Project 300 was very important and beneficial to the Brazilian Air Force. Besides considerable improvements to the supply system, it brought a great evolution in terms of data processing, such as the creation of the Air Force Data Processing Center in 1972, initially deemed necessary to give the Brazilian Air Force self sufficiency to manage and run the Project 300 system (up to that time the system was maintained through service contracts with the IBM of Brazil), and later expanded to serve many other areas in the Brazilian Air Force besides logistics. During these 27 years that went by since the Project 300 was first introduced in the Air Force, it was constantly modernized. In 1968 it was entirely reprogrammed in COBOL, and in 1982, with the introduction of the IBM 4341 machines

in the Brazilian Air Force, the Project 300 was completely updated to fit this new environment (1:IV). A basic characteristic of the system, however, remains unchanged since the beginning: it treats the aircraft separately of each other. This trait is inherent to the system's philosophy, and it was entirely assimilated by the Air Force as evidenced by the way the Project 300 was introduced in its logistics system: it was gradually extended to the various types of aircraft, one or two at a time. Due to the diversification of the Brazilian Air Force fleet (it is composed of airplanes from various origins, such as USA, France, England, Italy, and Brazil), and to the absence of a cataloging system, difficult and expensive to be established in such an environment, manufacturer's part number (PN) and manufacturer's code (MFR) have always been used in the Brazilian Air Force as key references to identify the supply items. Consequently the primary characteristic the Project 300 (managing the inventory of each type of aircraft separately) fits to the way of identifying the material practiced in the Air Force and was not viewed as inconvenient at all. It gave rise to the use of the expressions project and aircraft interchangeably to refer to each type of aircraft as a different project.

Today the Brazilian Air Force Logistics System still keeps these initial characteristics. It is basically composed of the Air Material Directorate, five depots, and several supply and maintenance squadrons at the base level

(1:Ch 1,1). The Air Material Directorate controls the depots' activities and establishes general policies and primary guidelines regarding the functioning of the whole system. Each depot is the single manager of one or more types of aircraft currently in the Brazilian Air Force Inventory. It means that once an aircraft, or any other equipment, has been acquired, and deployed, one of the depots is tasked with the corresponding logistics support (2:Ch 1,1). Then, most of the depot level logistics functions and tasks associated with each type of aircraft are performed independently by one of the Depots. That depot becomes the focal point for the support of that type of airplane, It is called the "central" for that project. Every base and squadron where that aircraft is deployed is linked to its "central" for all matters concerning logistic support as a "remote" for that "central" in that project. The system admits up to 99 "remotes" per "central" in each project. A depot can be the "central" for more than one type of aircraft and the bases and squadrons can be "remotes" of various "centrals", depending on how many types of aircraft they operate. A depot can still be a "remote" of an other "central"; this happens whenever a depot's maintenance shop performs services on components of an aircraft whose "central" is another depot or has an organic airplane whose "central" is another depot.

The automated inventory control system currently available for the logistic organizations in the Brazilian Air

Force to carry out their supply tasks is still the Project 300. The supply items, no matter their category (consumable, repairable, or equipment) are controlled separately by aircraft, in each of the depots, bases and squadrons. The key references used to register the items in the inventory control system are the manufacturer's part number and the manufacturer's code. The manufacturer's codes adopted are the DOD cataloging system's CAGE, listed in the H4 series publications. Brazilian manufacturers, as well as foreign ones not cataloged by the DOD, receive Brazilian codes, which are composed of five characters, the first two are alphabetic and the remaining are numeric.

This kind of organization offers some advantages: accounting per type of aircraft for example is facilitated, and maintenance and supply personnel become highly specialized and efficient as they constantly work with the same type of equipment.

Nevertheless, as the Brazilian Air Force grew, with additions in the quantities of existing types of aircraft and introduction of new ones, and became more familiar with the Project 300, some undesirable consequences of having a material management system organized per type of aircraft, not thought of as detrimental at the beginning, were more intensely perceived:

a. A considerable amount of part numbers are common to more than one type of aircraft. But, due to the systems' design, it is not possible to take complete advantage of this

compatibility. These items are administered as distinct materials in each of the projects using them. They require different item managers and different stock locations in various warehouses. It is even possible that the same item be treated separately in the same organization. For example, a squadron operating two diverse aircraft, may have the same item in each of these aircraft, stored in different places and controlled by different people.

b. Every month the system recommends stock replenishment of part of the inventory of consumable items based on the item's consumption during the previous twelve months. This task is performed per project. As a result, frequently identical items are ordered in different projects in the same or in successive Project 300's runs, generating non-economical purchase processes of the same item in small quantities each time. It is known in the Brazilian Air Force that such situations exist, and that managing these items together would be much more beneficial. However the Project 300 offer no means to do that.

To cope with these deficiencies and alleviate their effects, all individual aircraft projects were unified in a unique data base, and a global report of the part numbers existing in the Brazilian Air Force inventory, including the stock of all types of aircraft, was created. All depots are provided with this global list, in microfiche, every month. Whenever a depot runs out of stock of an item in one of their projects and a situation of emergency (MICAP) arises for that

particular item, that depot refers to the global list of part numbers attempting to obtain the item from another "central" before any other measure such as issuing an urgent requisition. Additionally, modifications were introduced to the reports received by the depots every month containing the system's recommendations of stock replenishment in each of their projects. If these items elected for stock replenishment exist in other projects, information about their stock and average consumption in those other projects, extracted from the same data base mentioned above, appear on these reports, to be observed by the depot's analysts before ordering compatible items. Although valid, these tools introduced in the system to compensate its perceived weaknesses increased human workload and their effectiveness is conditioned to human failures.

c. Another feature that the system maintains, since the Brazilian Air Force started employing it, is that only past consumption is automatically considered in the forecasting of consumable materials. The users are not provided by the Project 300 with suggestions for stock replenishment of consumable items based for example in a future fleet effort (in terms of flying hours) greater than usual, that would require more overhauls of major components in the following year than in the previous one, and would result in an augmentation of the requirements of consumable items to be applied in those more frequent revisions of major components revisions. The system possesses no means of anticipating

such situations, and in case they occur, consumable items shortages are likely to happen because their past consumption will not have recommended stock replenishment in a level high enough to support that unexpected increase in demand. The effects of this problem are most felt in the depots, where there is lack of mechanized means for them to accurately predict the consumable materials necessary to carry out their maintenance programs. In the Brazilian Air Force, the activities of aircraft general revisions and major components overhaul performed by a depot during a year is called the depot maintenance program. The depots normally plan their maintenance programs one year in advance. They have learned, through past experience that as a rule the predictions automatically made by the Project 300, based on past consumption, of future demand of consumable items do not cover completely their maintenance program needs. Then quantifying consumable materials needed to support the depot's maintenance programs is part of this planning process. To do this task, the main inputs used by the depots are the fleet effort scheduled for the following year (flying hours), the mean time between failure of the major components (MTBF), and information on the consumable items dependent demand, that is their demand as a function of their major components' overhaul, which basically includes quantity per next higher assembly (NHA), and whether the replacement of a determined part is mandatory or not in its NHA's overhaul. There has never been any problem for the depots to figure the

two first factors: fleet effort and MTBF. With reference to the third, dependent demand data, the need of collecting such information has been noted in the system since the Brazilian Air Force adopted it. Consequently, adding this capability to the Project 300 was part of its evolution in the Brazilian Air Force. Today, all depots' maintenance shops are provided with a report, produced in the monthly runs of the system, listing the major assemblies under their responsibility, the consumable items composing them, and their corresponding dependent demand information.

Another tool available in the Project 300 to support the planning activity is the inspection code. This code is entered on every consumption transaction issued to any item in the system. It specifies in what kind of service an item was consumed. Table on the next page lists the inspection codes and their meaning (1:5-19).

Then, if a depot's shop needs to know the consumption of a consumable item in the services of maintenance performed on its NHA, it just has to look it up on the corresponding Project 300 report that list the consumption per inspection code, under the code 5000. The only problem is executing the planning process manually. The depots do not have a computerized system to help them perform this task. Again the high human workload and human limitations involved reduce effectiveness.

In general the system is well managed, each organization performs its tasks correctly and on time, and tries to make

Table 1
Inspection Codes used in the Project 300

Inspection Code	Type of Service
1000	Depot level services of general revision on aircraft
2000	Organic or base level services of programmed maintenance on aircraft
3000	Organic or base level services of non-programmed maintenance on aircraft
4000	Maintenance on aircraft from an another project or not belonging to the Brazilian Air Force
5000	Overhaul of major components or assemblies
MISC	Any maintenance service different of the above

use of the system's resources as best as possible. Besides that, the system has been updated since its introduction in the Brazilian Air Force, and it is currently tailored to the Brazilian Air Force needs. However, deficiencies still exist, and shortages of material occur at the operational and depot levels. Therefore, it is important to examine the system and its deficiencies and to search for means of better employing the information provided by the Project 300 and its capabilities to correct or at least minimize its imperfections.

Scope

The idea of writing this thesis comes from an awareness of the deficiencies mentioned above, which the authors have learned during their past professional experience with the Brazilian Air Force system. The purpose of this thesis is not the creation of a new system. It intends only to suggest modifications that would solve, or at least reduce to acceptable levels, some of the system's current problems.

The kind of functional organization presented by the Brazilian Air Force's Project 300 offer some advantages, such as developing a great extent of expertise in the support of each existing model of aircraft, since the depots become very familiar with the particular equipments they maintain, and easy accounting per type of aircraft. Additionally considerable efforts have been spent to keep the system updated and adequate to the Brazilian Air Force needs. However, some problems in several logistics areas would probably be detected after a careful examination of the Brazilian Air Forces' logistics system. This study, will address some of the problems related to material planning procedures.

Specific Problems

a. Several supply items are common to more than one type of aircraft. They are managed independently in each of these aircraft, by different or by the same depot, in case the aircraft using the common items are assigned to the same depot (1:Ch 1,3). Consequently, there is duplication of effort in the management of identical supply items. Currently, the inventory control system does not include any provision for administering these common items together; that is, all of the depots use the same system, and the items have the same part number, however each type of aircraft is treated independently in the Project 300 (1:Ch 3,2). Furthermore, since the key reference used to register the supply items in the system is the part number, the fact that items serving the same purpose may be manufactured by different firms under diverse part numbers is not taken into consideration by the system. Consequently, it becomes difficult to detect and to take advantage of such relationships among these items (using them interchangeably for example). Their distinct part number and manufacturer code characterize them as different items, as they really are, and no means exists in the system to reveal their similarity. Moreover, requisitions for stock replenishment are issued by the depots independently of each other, originating successive non-economical purchases of the same

consumable items applied in more than aircraft, in small quantities each time.

b. The system recommends stock replenishment for a fraction of the inventory every month, based on each item's consumption throughout the previous twelve months (1:Ch 6,4). Each month these recommendations are individually checked. At that time, there is a chance of complementing the system's predictions by manually altering the quantities of items being ordered based on factors other than past consumption. Among these factors are the data related to dependent demand items, that is, consumable items applied in major components, which future needs can be anticipated by considering their quantity per next higher assembly (NHA), as well as how many NHA are scheduled for overhaul in the following year (determined as a function of the NHA's mean time between failure or time between overhaul, and fleet flying effort). Nevertheless, human limitations reduce the effectiveness of this task to a considerable extent. As a result, past consumption, which by itself has not proven to be a hundred percent efficient tool in the prediction of future material needs, influences it the most, and shortages, as well of excesses of supply items are not rare events in the system.

Research Objectives

The existence of the difficulties mentioned in paragraph "a" above can be explained as a natural consequence of assigning the depots separately as single managers for each project (type of aircraft). Also, a cause for the problem described in paragraph "b" can be found in the unavailability of an alternative automated method to predict future needs of consumable items, that would consider factors such as information on dependent demand items to supplement the classical forecasting technique employed by the Brazilian Air Force, based solely on past consumption.

Consequently, the objectives of this research are:

a. To show a way of identifying the common items currently in the inventory and to suggest the adoption of the item manager concept to manage them. That is, instead of being administered by aircraft, they would be controlled by item and assigned to a single manager, regardless their final application.

b. To determine if the employment of a method to forecast future needs of consumable items, based on the concept of dependent demand, to supplement the current forecasting technique used in the Brazilian Air Force, would be advantageous for the system.

II. Literature Review

Introduction

With reference to the second objective of this thesis, described in the last paragraph of the previous chapter, two possible ways to improve the Brazilian Air Force's inventory control system in terms of consumable items forecasting are feasible. One would be to look for a forecasting technique more complete or better than the one currently employed that would replace it; another would be to develop a method based on fundamental material requirements planning (MRP) concepts, such as dependent demand and bill of materials, that would supplement the current forecasting technique's predictions of future needs of consumable items, without changing it at all. This chapter's purpose is to examine some basic MRP theories, as well as some forecasting techniques applicable in inventory control systems, in order to provide the necessary background for further analysis of possible improvements in the Brazilian Air Force's inventory control system.

Inventory Planning

A first point deserving attention is the difference between dependent and independent demand items. This differentiation is very important because it is useful in selecting a given material management technique to be used in a production environment (3:578-579). Furthermore, the distinction between dependent and independent demand makes up the basis for most theories supporting the material requirements planning model (12:22). By definition, a supply item has dependent demand whenever its necessity is related in a direct way to the need of a higher level item (4:6). In technical orders the higher level item is generally called "next higher assembly," (NHA) (8:11). A dependent item's consumption pattern in most cases has a fixed correspondence to its NHA usage pattern, or it presents little variance over that model (4:5). For example, if a car manufacturer plans to assemble one thousand model "A" cars per day, it is easy to figure out the number of tires and steering wheels the company will have to buy to face production needs. In fact, the demand for those items is dependent on the number of cars that will be made (4:5). The MRP model takes special care of dependent demand items because managing them may be logically linked to a plant's production schedule. This is discussed below under the heading "A Model for Managing Dependent Demand Items."

Conversely, an item has independent demand when it is not possible to establish a direct correlation between its demand and a next higher assembly component (12:22). The number of windshield wipers that have to be changed during a normal car's maintenance will depend on the general condition of the item itself. So, windshield wiper is an example of independent demand item.

For sure the best way to predict future consumption of independent demand items is one of the several forecast methods, which employ information on the past consumption of a given item to figure out its most probable demand pattern in the near future. Some of the forecasting techniques applicable to independent demand items are discussed below.

Forecasting Methods

Any kind of forecast is based on some relationship or real data pattern. Time series is classified as a forecasting technique that predicts future demand from past internal data. It consists of a set of observations relating to a variable, ordered in time and collected during successive and equal periods of time (17:41). Time series analysis uses historical data, which are analyzed and decomposed to determine the pertinent components affecting the variable being forecasted. One or more of the following components may be present in time series data:

a. Level. It exists in all data, and represents the central tendency of a time series at any given time;

b. Trend. It characterizes the rate of growth or decline of a series time goes by;

c. Seasonal variations. They are annually repetitive movements above and below the trend line and occur when demand oscillates in a recurring pattern from year to year; for example, data vary, depending on seasonal regular factors, such as months in the year;

d. Cyclical variations. They are long term oscillations about a trend line and explain some of the variation between the trend line and raw data points. Major non-regular factors such as changes in the economy could define a cycle; and

e. Random variations. They have no distinguishable patterns and frequently assigning specific causes to them is not possible. They consist of residuals, noise, or irregular variations, caused by unusual conditions such as measurement errors (17:43).

> The components (except for the random variations) then are projected forward into the future. If historical components persist into the future, a reliable forecast will be obtained. (17:41)

Time series is preferred for short period predictions of stable variables (16:21). Moving average, exponential smoothing and regression analysis are some familiar time series models that use a sample of past data to predict future events (3:223).

Smoothing Techniques. Some existing pattern in the variable being forecasted constitute the basis for the smoothing forecasting methods. Random errors are expected to exist between the real and the predicted values of the variable being analyzed. This technique mitigates the influence of extreme observations as the values are smoothed or averaged. The moving average and single exponential smoothing are techniques appropriate to forecast data presenting a broad horizontal pattern (7:38-40).

Simple Moving Average. The simple moving average method uses observations taken during periods of time. The values of each observation are summed and divided by the number of observations (7:41). Negative effects of random variations are reduced by using a high number of observations, because values will be averaged (7:42). Then, to employ this technique successfully, historical information is important (18:32). The simple moving average formula is:

$$F_{t+1} = \frac{V_t + V_{t-1} + V_{t-2} + \ldots + V_{t-N+1}}{N} \qquad (1)$$

Where,

F_{t+1} - Next period's prediction,

$V_{t,t-1,t-2,\ldots}$ - Observed past values, and

N - Total number of observations (7:43).

The moving average forecast offer fast responses to changes in the data, mainly when a small number of observations is used. Then, data presenting high random variation

will not be forecasted accurately through this method. (7:46-47).

Weighted Moving Average. In this method, instead of being given equal weights, each component of the moving average database can receive different weights, providing that the sum of the ratio of each individual weight divided by the sum of all weights equals 1 (3:225). They are assigned depending on the relative contribution of each period's observation to the following period's forecasting. The forecaster will assign weights based on past experience with the data; that is, the combination of weights found to provide the best forecasting will be used. Adjustments (changes) can be made whenever they are desirable or convenient. In the example below the forecasting is based on the four previous periods, and the best combination of weights was considered 12, 8, 6 and 5 to the last, first before last, second before last, and third before last periods respectively:

$$F_{t+1} = \frac{12V_t + 8V_{t-1} + 6V_{t-2} + 5V_{t-3}}{31} \tag{2}$$

As mentioned above, the sum of the ratio of each weight divided by their sum equals one (12/31 + 8/31 + 6/31 + 5/31 = 1). In comparison to simple movinq average, the weighted moving average offers the advantage of adjusting the effects of past data whenever needed (7:47).

Single Exponential Smoothing. In this technique, like in the weighted moving average, weight is given to the data. The difference is that more recent observations receive higher weights than previous ones, and a constant, alpha, is used in the calculations. Basically, the new forecast is adjusted by adding a fraction of the current forecast's error to the current forecast. Alpha is the proportion of the current forecast's error used for the correction (3:227). The weights given to past data decrease exponentially with time, as illustrated below:

$$F_{t+1} = \alpha V_t + \alpha(1-\alpha) V_{t-1} + \alpha(1-\alpha)^2 V_{t-2} + \ldots + \alpha(1-\alpha)^{n-1} V_{t-(n-1)} + (1-\alpha)^n F_{t-(n-1)} \tag{3}$$

Where:

$V_{t \text{ to } t-n}$ - Observations,

Alpha - Constant, with value between 0 and 1,

F_{t+1} - Next period's forecast.

A practical form of this expression is:

$$F_{t+1} = F_t + \alpha(V_t - F_t) \tag{4}$$

Using values of alpha close to 1, a higher proportion of the error from the previous forecast will be considered in the adjustment of the new forecast. (7:47-48).

The following characteristics of exponential smoothing are responsible for its superiority in comparison to moving averages:

a. More recent data have more influence in the forecast;

b. The quantity of data that needs to be kept in storage is lower;

c. All previous data, since the technique begins to be used, contribute to the forecast. In the moving average, an arbitrary cutoff point exists, for example 6 or 12 periods; and

d. The model is more flexible. Alterations are easily made, simply by changing the value of alpha (7:51).

Classical Decomposition Technique. This method divides the time series pattern in the subcategories cyclical, seasonal, and trend. The original series forecasts are the results of analysis, extrapolation, and recombination of the individual sub-patterns (18:679). The formal classical decomposition model's expression is:

$$V_i = T_i \times S_i \times C_i + I_i \qquad (5)$$

Where:

V = variable's value;

T = trend factor;

S = seasonal factor;

C = cyclical factor;

I = factor representing the irregularity of the time series; that is, its random component; and

i = indicative of the observations' period.

Decomposition analysis offer some advantages such as:

a. It provides information capable to serve as a basis for short term planning;

b. It enables determining the long-term tendency of the variable being analyzed; and

c. It is applicable to a wide range of business situations (7:63-65).

On the other hand, the method presents some limitations, its time series pattern does not allow causal relationships to be represented.(18:91).

Simple Linear Regression. In this forecasting method a line is fit through the data points. Its major restriction is the assumption that future observations and past data will fall about the same line (3:237). Besides being limited to linear relationships, obtaining statistically significant results depends on the availability of a great quantity of data. Furthermore, all data observations are equally treated; that is, the technique provides no means of considering observations related to one period having more influence in the final result than the ones corresponding to another period (18:66). On the other hand, simple linear regression offers the advantages of forecasting time series and causal models and of feasibly analyzing much greater quantities of data than it is possible with intuitive or manual methods (18:66). The characteristic of the simple linear regression model is that only one independent variable affects the dependent variable. The applicable equation is:

$$F_{t+1} = a + bX_t + U_t \quad (6)$$

Where:

F_{t+1} = dependent variable;

X = independent variable;

a = constant,

b = slope of the line (the change in the value of the dependent variable corresponding to a one unit change in the value of the dependent variable);

U = error term (7:101-102).

The least squares method can be employed for the determination of the terms a and b. The basic premise of the least squares method is minimizing the sum of all observations' square deviations. The deviations are obtained by subtracting the predicted values from the corresponding actual observation's value (7:103-104); in other words, the least squares method attempts to minimize the sum of the squares of the distances between each unit of data and its corresponding point on the assumed line (sum of square errors) (3:238). The line fit through the available data using the least square method is the one that has a smaller sum of square errors than any other line model (11:493).

Multiple Regression Analysis. The only difference between simple and multiple regression analysis is that the last one uses more than one independent variable for the prediction of the dependent variable. The limitations and

strengths of the previous one apply (7:119). The multiple linear regression's expression is:

$$F_{t+1} = a+b_1X_{1t}+b_2X_{2t}+\ldots+b_kX_{kt}+e_t \tag{7}$$

As a common feature, the forecasting methods mentioned above provide information based mainly on past observations. They do not present the best results when common demand variability caused, for example, by product demand fluctuation, is involved; nor offer a remarkable performance when supporting a maintenance environment. Despite being the only possible option to deal with independent demand items, these forecasting methods should be complemented with more information on future demand whenever possible. Models providing complementary information for dependent demand items exist. One of them is discussed next.

A Model for Managing Dependent Demand Items

The fact that dependent demand items are easily linked to the quantity of end items scheduled for production offers a great opportunity to improve stochastic forecast methods' reliability related to dependent articles. So, a manufacturing organization may calculate its future necessities in terms of dependent items, by estimating its future production of major assemblies (3:627). Integrating the

production schedule to dependent materials' needs is made possible by the material requirements planning (MRP). MRP is a collection of computer programs aimed at simulating a manufacturing environment (15:454). The organization's production capacity, the master production schedule, and the list of materials needed are the foundations from which MRP programs will estimate the required quantity of spare parts, and when they will be necessary in the production process (12:46-51). Also, the production goals themselves can be tested through MRP capability. Therefore, MRP is valuable, since it can access the production plan's feasibility by evaluating the main variables that make up the production process, prior to its implementation (13:31).

MRP Basic Concepts

To assure production cycle's continuity the supply system has to order the correct material at the right time and in the most economical way. That is, raw materials and spare parts have to be purchased in advance in order to assure their availability in inventory when they are needed. The order point and material requirements planning are two methods employed for ordering these supply items (19:47). In the order point model, which is used basically to order independent items through methods such as the ones already mentioned, the tool used to calculate the "when" and the "how

many" to order is the past consumption extrapolated to the future (19:47).

In a manufacturing environment most of the items employed have dependent demand. Therefore, the material requirements planning system will use only information on dependent demand, obtained from the bill of materials and inventory records file. In a maintenance environment, the same item may present dependent and independent demand. For example, a screw may be a dependent demand item if its replacement is mandatory in the overhaul of a major assembly, and it may be an independent demand item if it is used at another location in the airplane, where its replacement follows an "on condition" replacement procedure.

The inputs for the material requirements planning system are the master production schedule (MPS), independent demand forecasts, external orders for components (12:49), inventory records file, and bill of materials file (3:629). Orlick represents the MRP inputs feeding directly into the MRP module (figure 1). Other authors, like Chase and Aquilano, represent demand forecasts and customers orders feeding into the master production schedule module (figure 2).

The MRP module provides the possibility of calculating necessary materials in terms of parts and raw materials by comparing the bill of materials to information such as production schedule and plant's capacity, which are provided by the master production plan. MRP also includes the

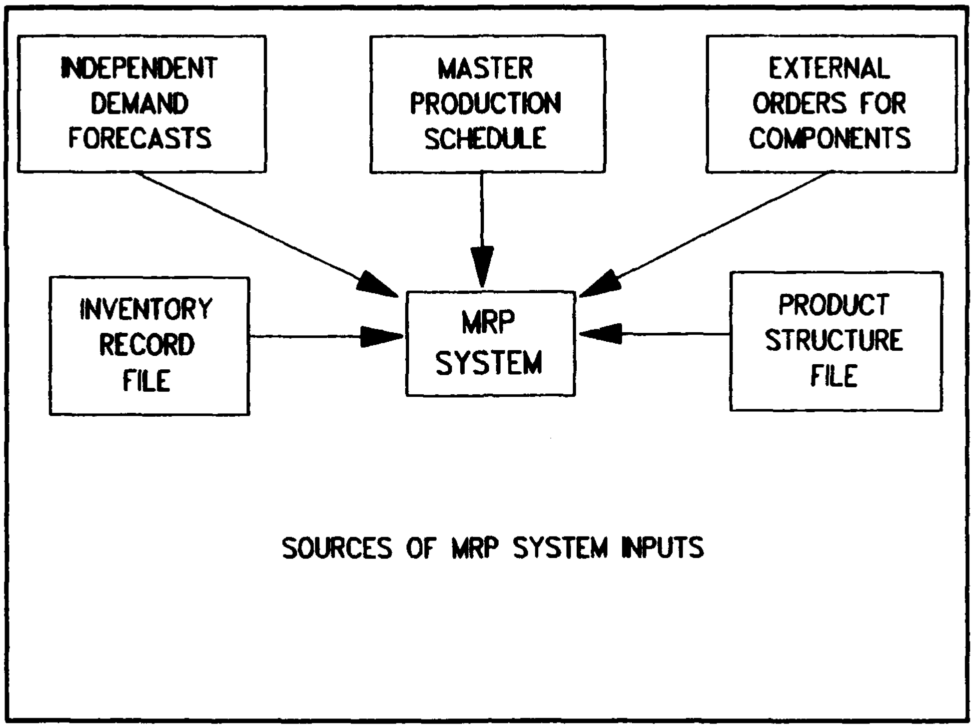

Figure 1. MRP Inputs (Chase & Aquilano)

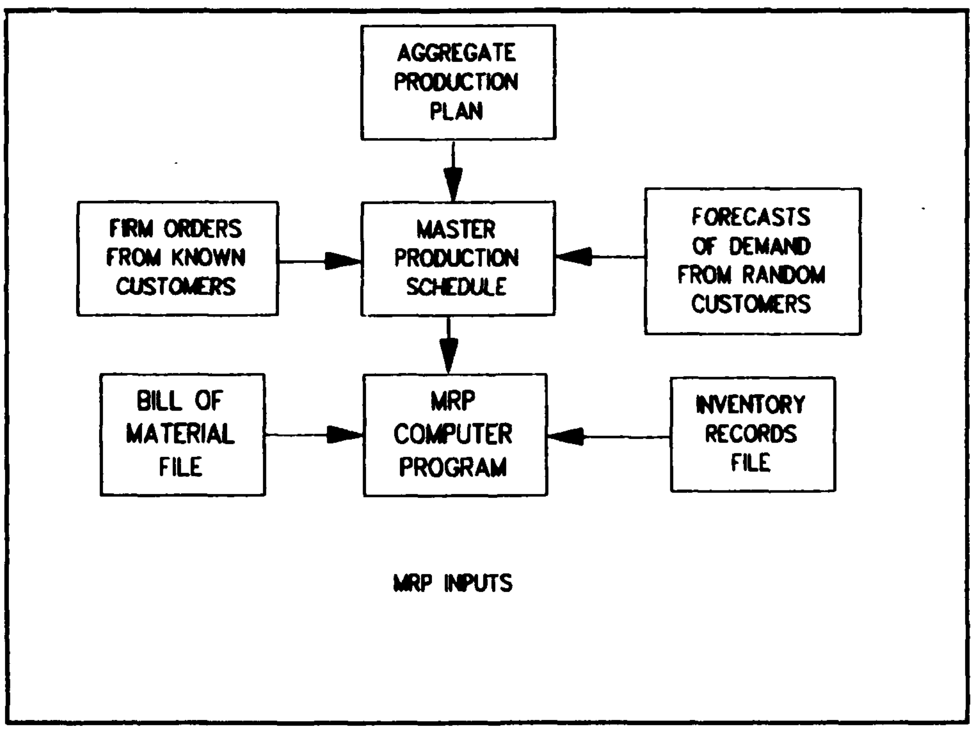

Figure 2. MRP Inputs (Orlick)

capability of comparing necessary materials to existing inventory and pending orders, with the purpose of verifying if material requirements to satisfy the production plan will be available when needed (14:108).

Master Production Schedule (MPS). MPS contains the overall production schedule in terms of type and quantity of items. It observes management policy , expressed in the production plan, and breaks it down to the detailed level, stating what is going to be manufactured (19:199). It also breaks down the time schedule required to accomplish each step of the planned production. Product needs are broadly specified, in terms such as groups of products, in the aggregate production plan. The master production schedule goes one step further, by identifying each item to be produced, furnishing details such as quantity and time period to be completed (3:630).

> The master production schedule serves as the main input to an MRP system, in the sense that the essential purpose of this system is to translate the schedule into individual components requirements, and other inputs merely supply reference data that are required to achieve this end. (12:50)

Independent Demand Forecast. Besides MPS, information about independent demand items are also sent to the MRP module, which may be designed to receive data already processed. This means that lead times and estimated units per NHA are computed by another program, and in the MRP only the total number of items is calculated. Another possibility is to perform all calculations, including demand forecast,

within the MRP module (12:50). Chase & Aquilano describe two main sources of product demand for end items. The first is specific orders placed by known customers, that do not need any forecasting and are simply added up. The second is the forecast demand; these are independent demand orders, which are predicted using a forecasting model. Both become MRP inputs, which are introduced through the MPS (see figure 2 above) (3:629). Additionally, they mention that orders for specific parts and components, less complex than the end item, are fed directly into the MRP program at the appropriate levels, instead of being introduced in the MPS (3:629,630).

External Orders for Components. Orlicky includes the external order for components as one input data to the MRP module. The information carried out by this module is related to orders generated outside the plant and not pertaining to the production plan. Components ordered by other plants, or used as spare parts by customers are included in this category. Those requirements are sent to the MRP module and added to the number of similar items that have to be supplied to production system (figure 1).

Inventory Records File. The inventory record file, also called item master file (12:50), contains information about inventory transactions, orders status and lead time, and current level of stock . It also includes data related to economic lot size, unit of issue, shelf life and other characteristics related to each individual article registered

in the file (3:640). These are information useful for determining lot size and frequency of requisitions (12:50).

Bill of Materials File. The bill of materials file contains the relation of parts (including raw materials) used to manufacture or to assemble a given component. It also contains the amount of parts needed, and the sequence on which those parts are used in the assembling process (19:220). Therefore, the bill of materials is a key element in the material planning process performed in the MRP module (10:107). Starting from the end article, the interrelation among items that will be used in its assembling generally resembles a Christmas tree, in which the end article occupies the top position and several levels of materials are placed below. Each level may represent, for instance, a step in the manufacturing procedure (14:134). Therefore, to figure out how many dependent subitems will be necessary to manufacture a planned quantity of an end article is a straight forward process. It consists of retrieving from the bill of materials the quantity of each subitem used per end article, and multiplying these quantities by the number of end articles to be made. Nevertheless, the process became much more time consuming and also more complex when hundreds of different types of end articles and thousands of dependent items per end article are involved, and when a subitem is used in several assembly levels of the same end article and in several types of end articles. Therefore, organizations possessing a very diversified production line should analyze

the option of adopting the modular bill of materials design as a technique for managing the complex interrelation network that will be formed in the common bill of material's configuration (12:228). Modular bill of material (MBM) is defined as:

> A bill of material used for master scheduling that expresses the materials requirements for a product without showing the final configuration of the product. Modular bill of material for an automobile, for example, would list the engines, transmissions, body styles, etc., rather than attempting to show the final configuration of a specific automobile. (19:529)

The MBM provides important advantages when used in diversified product lines. Smolick mentions the following benefits:

a. Provides maximum product flexibility;

b. Provides better data visibility;

c. Assures parts compatibility;

d. Simplifies training of new personnel.

He also lists some disadvantages such as:

a. Implementation would temporarily disrupt routing system flow;

b. Assembly areas would have to be restructured according to function models;

c. Not applicable to product lines with few variations.

MRP in the USAF

The MRP concept is used in the USAF as a component of the manufacturing resources planning (MRPII) which is implemented in the maintenance environment (5:8). In this ambience it is much more difficult to use MRP ideas than in production lines because of the uncertainty associated with material demand in the maintenance processes. In the Air Force, MRP is part of the Depot Maintenance Management Information System (DMMIS), whose implementation is an AFLC responsibility (5:8). The MRP model is employed within DMMIS in the same way it is used in manufacturing. The main difference can be noticed in the output generated by MRP in the two environments. In manufacturing, MRP generates information about what is really needed, while in the maintenance environment, due to the uncertainty included in the calculation process, its output represents only an estimation about what is needed (5:10). However, efficient operations in both environments depend on advanced planning. Besides that, DMMIS compensates the Air Force environment's particular characteristics in several different ways: in the Air Force Logistics Command, the Directorate of Maintenance has the Directorate of Material Management as its unique major customer, which simplifies demand and production planning; the Air Force Requirements Data Bank (RDB) is used by inventory management specialists to estimate worldwide requirements for serviceable assets and availability of

reparable units before negotiations of required levels of support; some workloads, such as packages for aircraft overhaul, are reasonable predictable; and rough estimates must be used for non-programmed workloads (aircraft accidents, battle damages and random failures). In addition, DMMIS includes an automated interface with the RDB, which will reduce the lead time to disclose Air Force worldwide requirements and will support prompt efficient negotiation of new or modified work loads (5:10). In conclusion, MRPII, which contains MRP, is considered a powerful tool for improving depot maintenance effectiveness, due to its potential capacity of minimizing repair time and inventory level (5:11).

Is MRP Still Useful?

Several articles have been written telling that models following the Material Requirements Planning concept already fulfilled their old promises and have no place in the modern management world anymore. The Japanese way of managing seems to be the only correct technique available to administer. Kanet, for example, says that MRP has basic problems, for which solutions cannot be reached, no matter the amount committed of data accuracy, realism in master schedules, management involvement, or employee training. He mentions that lot sizing is done prior to and independent of capacity

planning and sequencing/scheduling; as a result production plans are frequently found to be infeasible at a point too late in the planning process to afford the system the opportunity to recover; to account for this basic weakness, inventory buffers and planned lead time are implanted everywhere within the system. He still cites that because planned lead times are management parameters which are provided prior to the planning process, they cannot explicitly take into account the sequence in which jobs will be processed. Then, every order is budgeted enough planned lead time to permit it to be sequenced first, which causes a great waste of work-in-process inventory (9:59).

Other authors, however, view MRP differently. MRP models do not became obsolete due to the evolution of Just in Time (JIT), KANBAN, and other management concepts (6:213-217). MRP employs production schedule and production capacity parameters as basic support for calculating future material demand requirements (13:31). JIT main objectives are to minimize work-in-process inventory, to optimize production efficiency and effectiveness,and to minimize the amount of resources employed in the production process (15:448). JIT has been successfully employed in repetitive manufacturing environments, in which the production schedule is not the subject of frequent changes (3:643-644). MRP uses information such as plant's production capacity and parts used per product to forecast, in the short and in the long run, the material, as well as the economic requirements, for

accomplishing the production plans. Consequently, MRP is a valuable tool to complement JIT weakness regarding to the environment's variability (13:36).

Conclusion

The subdivision of supply articles into dependent demand and independent demand items constitutes an opportunity to examine different materials planning techniques in managing articles belonging to these different categories.

Therefore, the management of independent demand items may be performed through forecasting techniques, as described previously in this text. A variety of forecasting techniques exist. Depending on data pattern, availability of resources, and numerous particular factors, a specific method will fit a determined need better. So, the basic characteristics of some methods, simple moving average, weighted moving average, exponential smoothing, classical decomposition technique, simple and multiple regression analysis, as well as their strengths and limitations were reviewed.

Dependent demand items may be logically linked to the end articles in which they are applied. Consequently, material planning models exploring these characteristics have to be considered as a possible useful tool for managing this type of material.

The Brazilian Air Force's inventory control system currently employs the simple moving average forecast technique to predict future demand of expendable supply items. The system does not provide the users with any automatic tool that would improve the forecast of consumable items with other information besides past consumption, such as dependent demand data. Other forecasting techniques could fit the consumable items behavior pattern better than simple moving average, however either would still stress past consumption in anticipating future needs, without giving attention to factors such as hours to be flown by the fleet in the following year, mean time between failures of next higher assemblies, and quantity of consumable item per NHA. Consequently, developing a method that would use dependent demand information as a means of closing the existing gap in the BAF system's consumable items forecasting, would be more profitable for the Brazilian Air Force than investing in trials of different forecasting techniques. Then, one of the issues in this study, as stated in research objective "b" on page 5, is to show the feasibility of developing such a method, using information already available in the system. The material put together in this literature review, mainly the basic MRP concepts, will be employed later to demonstrate how an alternative procedure to foresee requirements of consumable items, whose demand can be treated as dependent on their NHA consumption in the Brazilian Air Force's system, could be created. The system's peculiarities would be taken

into consideration, and the procedure would not interfere with the forecasting method currently in use, but supplement it.

III. METHODOLOGY

General Issue

The overall objective of this thesis is to demonstrate the feasibility of adopting the item manager concept, for common items, in the administration of the Brazilian Air Force's inventory, and to show how the current forecast of consumable items could be supplemented by a method based on fundamental MRP concepts that would consider information on depend demand.

Specific Problems

Due to the assignment of the Depots as single managers for the entire aircraft, there is duplication of efforts in administering identical items; the system generates monthly requisitions of low-cost expendable items in small quantities; and future needs of consumable items are forecasted solely on the basis of past consumption, originating shortages of certain items, as well as excesses of others.

Investigative Questions

The problems mentioned above seem to exist due to the way the system is organized. The questions described below, if successfully analyzed and answered, would probably provide an initial approach to the correction of these most significant problems presented by the system. The solutions found, if implemented, would constitute a considerable improvement for the system as a whole:

a. Is it possible to reorganize the system, modifying the concept of assigning the management of all items from an aircraft to a single depot, and adopting the item manager concept for common items? That is, common items would be assigned to the same depot, regardless of their final application.

b. Would a method based on the MRP concept of dependent demand be adequate to supplement the current forecasting technique employed by the Brazilian Air Force's inventory control system for consumable items? That is, would such a method be useful to improve the current effectiveness in the prediction of future demand of consumable items presenting dependent demand?

Particular Method

Investigative Question a. The Brazilian Air Force Inventory Control System keeps a complete record of each part number from the time it is first registered in the system (1:Ch 4,3). Besides part number and manufacturer code, information such as national stock number, past consumption, application, unit price, alternative items, and source of supply are easily obtained from the system (1:Ch 4,1). The inventory is controlled separately by aircraft; however, a general data base containing information about all part numbers from all types of existing aircraft is available (1:Ch 4,7). Several items do not come from the United States, and will not have complete national stock numbers. In this case, only the item's class is registered in the system.

To carry out the research necessary to answer investigative question a, a file containing the entire population of part numbers registered more than once (that is, repeating), corresponding to consumable items used in all types of Brazilian Air Force's aircraft, with a total of 30103 registers, was extracted from this general data base, which is currently installed in an IBM 4341 OS/VS1 environment. The data-file was converted to an ASCII type file and diskettes 5 1/4 double side, double or high density were used. The diskettes were formatted in the IBM/PC DOS pattern. The data-file structure is presented in table 2 on

the next page (the field names therein are the original ones used in the BAF, and their meanings are described in english in the last column of the table). This structure is the same of the general data base, where materials of all categories are registered, from which the data-file was extracted. Since only consumable items are registered in the data-file, the fields corresponding to information exclusive of reparable items (category "R") contain zeros or blanks. Adopting the item manager concept in its entirety would encompass a drastic shift in the Brazilian Air Force's inventory control system's philosophy. This would require such deep modifications that the current software would no longer be appropriate, and a totally new system's analysis would have to be performed. Besides that, such a new philosophy would require the creation of a cataloging system, not available currently in the Brazilian Air Force's supply system. This development could be beneficial, but probably unfeasible due to lack of material and human resources.

The Brazilian Air Force's inventory control system views each depot as the focal point in the management of one or more types of aircraft (the "central"), and all operating units (bases and squadrons), the "remotes", are linked to one or more "centrals" depending on the number of different equipments they operate. This same structure would be maintained in the reorganization of the system mentioned in investigative question "a". Consequently, no modification in the current computer programs would be necessary, only

Table 2

Data File Structure

Field Number	Field Name	Meaning
1	PN	Part number
2	PROJ	Type of aircraft
3	MFR	Code of manufacturer
4	NSN	National stock number
5	NAME	Item's name
6	UI	Stock unit
7	CATEGORY	Item's category
8	ORIGIN_AQ	Origin of acquisition
9	APPLY-CODE	Application code
10	TPR	Average lead time
11	FRG	Revision factor
12	TRG	Revision average time
13	OFIC_CODE	Shop code
14	CMM	Average consumption
15	TOT-STQ	Total stock
16	CRED	Item being ordered
17	MEAN_PRICE	Item's price
18	CONTABIL	Accounting code
19	SHELF-LIFE	Item's shelf life
20	LAST_AQ_PRICE	Last order price
21	SUPERADOR	Superseding part number
22	SUPERADO	Superseded part number
23	ALTERNADO	Interchangeable part number
24	P_REN_CALC	Reorder stock level
25	N_MAX-CALC	Maximum stock level
26	Q-REQ	Used in the programs
27	CODE	Used in the programs
28	CODE1	Used in the program

management procedures would have to be changed.

<u>Data</u>. To show that the modification proposed here is possible and feasible, the data-file cited previously, withdrawn the system's general data base, containing data from all types of aircraft currently in the system was handled using DBASE III. The goal of this analysis was to prove the existence of identical items in different aircraft, and to detect items with probability of being the same material, but presenting variation in their identification; that is the same item, requested by different Depots, sometimes by the same one, to be applied in different aircraft, would have been registered in the system slightly differently by each of those organizations. Once these items are plotted, it becomes a simple matter to reorganize the system so as to take their compatibility into consideration: one of the Depots would be assigned as the central for all common items, and all other Depots and operating units would be assigned as "remotes" of this Depot (the central for the common items). The current structure of the system would fit perfectly to this new situation, no software changes would be necessary, and only new management procedures would have to be adopted to implement it.

The following criteria were used to look for groups of items likely to be joined under the administration of the same central due to being common in diverse aircraft (projects):

a. Items with identical PN and NSN;

b. Items with different PN, but the same NSN;

c. Items with the same PN and the same manufacturer's code (CAGE), but different NSN.

To analyze the data in accordance with these criteria, the data-file was modified to a DBASE III type file (.DBF); the desired information were obtained through DBASE III programs written specifically to analyze each group of items mentioned above, and through the employment of the assist option of the DBASE III software. All items in the data-file were treated independently of their final application.

a. Analysis of Items With the Same PN and NSN. As mentioned previously, only groups of identical part numbers present in different aircraft or projects, which total 30103 records, are registered in the data-file. From this total, 7515 individual items with specific PNs and NSNs are duplicated in one or more types of aircraft. These 7515 individual PNs and NSNs together with their duplicates total 19863 records. Thus, there are 12348 (19863 minus 7515) duplicated records. The DBASE III program presented in Appendix A provides the user with the possibility of displaying on the screen or printing the list of these items. It prompts the user with a menu containing various options, such as directing the output to the screen or to the printer, choosing the number of the first record to be displayed or printed, choosing how many records to skip before beginning the list, choosing how many records to display or print in sequence and the number of registers to skip between

sequences, and abandoning or continuing the process once it has been initiated. Significant excerpts of the list of duplicated individual items with specific PN and NSN are presented in Appendix B (the total list would be composed of approximately 125 single-spaced pages).

The DBASE III assist option, as well as the DBASE III program presented in Appendix C, were employed to analyze these individual items with specific PNs and NSNs duplicated in one or more aircraft, and to provide the following information about them:

a.1. Detect the specific PNs and NSNs duplicated in one or more types of aircraft, and discriminate them by placing the digit "1" in the database field "code" corresponding to them.

a.2. Determine the total quantity of individual items with specific PNs and NSNs, duplicated in one or more types of aircraft in the Brazilian Air Force's inventory (Appendix D). Since the basic rule for an item to figure in the data-file is that it exists in more than one type of aircraft (project), the number of times that an identical item appears in the data-file is equal to the number of projects in which it is used. To obtain this figure, each duplicated item was counted only once, no matter the number of times it repeats in the system.

a.3. Determine the total quantity of registers that could be eliminated from the system; that is, registers corresponding to individual items with specific PNs and NSNs

repeated in more than one type of aircraft that could be canceled as a result of transferring their administration to a single manager (Appendix D). Each time the same item appears in the system, it counts as one register. As a consequence of employing the single manager concept, only one register would be needed in the system per common item (all current users' registers would be consolidated in one). Then, this figure was obtained by summing all registers corresponding to specific PNs and NSNs duplicated, subtracting one from each partial sum, and taking the summation of all partial results.

a.4. Total quantity of different requisitions for each specific PN and NSN present in more than one type of aircraft, that were being processed in the supply system when the data-file was withdrawn and would not exist if common items were centrally managed (Appendix D). This figure was obtained by summing the registers corresponding to each particular PN and NSN duplicated, which have the field "cred" (indicative of the presence of a requisition in the system for the item) greater than zero, subtracting one from each partial summation, and summing all partial results.

b. Analysis of Items With Different PN, but the Same NSN. The DBASE III assist option, as well as the DBASE III program presented in Appendix E, were employed to provide the following information about these items:

b.1. Detect specific NSNs duplicated in one or more projects (aircraft), with different PNs assigned in each of

these projects, and discriminate them by placing the digit "2" in the database field "code" corresponding to them.

b.2. Determine the total quantity of specific NSNs duplicated in one or more projects, with different PNs assigned in each of them, present in the Brazilian Air Force's inventory (Appendix F). To obtain this figure, each duplicated item was counted only once, no matter the number of times it repeats in the system.

b.3. Compute the total quantity of registers corresponding to specific NSNs duplicated in one or more projects, with diffeient PNs assigned in each project, that would remain in the system for reference only, as a result of transferring their administration to a single manager (Appendix F). This figure was obtained by summing all registers corresponding each duplicated item, subtracting one from each partial amount, and taking the summation of all partial results.

b.4. Determine the total quantity of different requisitions for each specific NSN duplicated in one or more aircraft, with different PNs assigned in each of them, that were being processed in the supply system when the data-file was withdrawn, and would not exist if the common items were centrally managed (Appendix F). This figure was obtained by summing the registers corresponding to each duplicated item which have the field "cred" (indicative of the presence of a requisition in the system for the item) greater than zero,

subtracting one from each partial summation, and summing all partial results.

c. Analysis of Items With the Same PN, the Same CAGE, and Different NSN. The DBASE III assist option, as well as the DBASE III program presented in Appendix G, were employed to provide the following information about these items:

c.1. Detect the individual items with specific PNs and CAGEs duplicated in one or more types of aircraft (projects), having different NSNs assigned in each project, and discriminate them by placing the digit "3" in the database field "code" corresponding to them.

c.2. Calculate the total quantity of items with specific PNs and CAGEs duplicated in one or more types of projects, having different NSNs assigned in each project, present in the Brazilian Air Force's inventory (Appendix H). To obtain this figure, each duplicated item was counted only once, no matter the number of times it repeats in the system.

c.3. Compute the total quantity of registers that could be eliminated from the system; that is, registers corresponding to items with specific PNs and CAGEs duplicated in one or more projects, having different NSNs assigned in each project, that could be canceled as a result of transferring their administration to a single manager (Appendix H). This figure was obtained by summing all registers corresponding to specific PNs and CAGEs duplicated in one or more aircraft, with different NSNs assigned in each

project, subtracting one from each partial sum, and summing all partial results.

c.4. Determine the total quantity of different requisitions for each individual item with a specific PN and CAGE duplicated in one or more projects, having different NSNs assigned in each project, that were being processed in the supply system when the data-file was withdrawn, and would not exist if the common items were centrally managed (Appendix H). This figure was obtained by summing the registers corresponding to each duplicated item, which have the field "cred" (indicative of the presence of a requisition in the system for the item) greater than zero, subtracting one from each partial summation, and summing all partial results.

Investigative Question b. To answer investigative question b, the MRP concepts of dependent demand item and bill of materials, associated with mean time between failures of reparable items (MTBF), were used to create a program in QUATTRO PRO, that demonstrates how these basic principles could be used by the BAF to develop a system able to supplement the current BAF system's forecast reliability. As mentioned previously, today in the Brazilian Air Force's inventory control system past consumption is the only input in determining when and in which quantity requisitions should be issued for stock replenishment of all consumable items in the inventory. The forecast method employed is the simple moving average using data from 12 months in the past.

Factors such as number of hours to be flown by the fleet in the following year, and mean time between failure (MTBF), are not immediately taken into consideration by the system; that is, a certain period of time will have gone by before past consumption adjusts due to these factors. Therefore, shortages or excesses of determined spare parts, applied in the overhaul major assemblies, which demand is highly dependent on the factors just cited are likely to occur upon variations in them, during the adjustment period.

The most detrimental effects of this problem are felt by the depot's maintenance program. As mentioned in Chapter 1, each depot's activities in terms of quantity of major assemblies to be overhauled is programmed annually. This is called the depot's maintenance program in the Brazilian Air Force. Spare parts needed by the depots to carry their programs out will supposedly be available in stock whenever demanded. In other words, past consumption will have triggered the system. Consequently, spares must have been requested on time and have already been delivered when the need for them arises. However, variations in the factors alluded to in the previous paragraph occur more as rules than as exceptions. Due to the system's slow response to them, the depots usually have difficulties keeping their annual maintenance programs on time. Shortages of spare parts, sometimes small and cheap ones, delay repairs of major assemblies, resulting in mission capability being impaired at the squadrons.

The depots should be provided with a prediction tool able to reflect more closely the ever changing conditions of their environment. Showing the feasibility of using information already available in the Project 300 to provide them with such a tool constitutes the second and last issue to be addressed in this thesis (investigative question b). Having in mind that spare parts applied in the overhaul of major assemblies (NHA) are dependent on the consumption of their NHA, the concept of dependent demand item, discussed in Chapter 2, applies. Then, some of the MRP basic principles, reviewed in the same chapter, would be useful in developing a system to help the depots minimize their maintenance programs difficulties.

Conceptualizing a complete MRP project is a very huge task, which would require resources far beyond the capabilities available to do this thesis. As stated in investigative question b, the goal here is only to suggest the development of a method that would supplement the current forecast technique employed by the system. Besides that, this method would not fit the system needs in general. It would be useful only for the depots to foresee their maintenance programs' needs in terms of dependent demand items. It would basically enable the depots to predict their requirements of dependent consumable items to overhaul major assemblies by taking into consideration number of hours to be flown by the fleet in the following year, number of major assemblies per airplane, major assemblies' MTBF, and quantity

of consumable item per NHA. Besides that, with such a program, any modification in previously forecasted quantities of consumable items deemed convenient due to alterations in the parameters mentioned above, would be easily and immediately determined. Then, the quantity of existing orders for the corresponding consumable items could be adjusted (reduced or incremented), and new ones could be placed as necessary, well in advance to allow for the materials' lead time, preventing the occurrence of urgent requisitions.

To show the feasibility of developing such a method for common usage by all the depots a program in QUATTRO PRO (shown on Appendix I) was written.

Data. Data corresponding to two major components from the C-130, engine and propeller, were used, These data were collected manually from the Project 300's report 35A of the C-130 central depot's engine and propeller shops. This report was briefly described in Chapter I. It lists the major assemblies revised in each of the depot's maintenance shops and furnishes dependent demand information about them, breaking them down per component.

Data About the Components. The following data about 35 components of the C-130's engine and 77 components of the C-130's propeller, were obtained from the mentioned report to be used in the program, and were directly typed in the QUATTRO PRO software: part number, name, category, credit, total stock, average monthly consumption, and

quantity used per NHA. Only components which replacement is mandatory whenever the NHA is overhauled were used (this information is still provided by the report 35A). The components' national stock numbers and manufacturer's codes, not present in the report 35A, were obtained manually from a list, in microfiche, of all the part numbers existing in the BAF inventory, available in the BAF Liaison Office on Wright Patterson Air Force Base. At this point it is important to make a comment about the average monthly consumption (AMC). The AMC listed on the report 35A, and used in the program, is the general consumption of the item in the project C-130. The components' average consumption only in repairs of their major assemblies are also provided by the Project 300, under the inspection code 5000, as discussed in Chapter 1. Using this partial consumption in the program would be more appropriate, but it was not available. One of the reasons that led to the choice of the C-130's engine and propeller was that most of their components are specific; that is, they are not applied very frequently in other parts of the aircraft. This makes their general consumption in the project close to their specific consumption under the inspection code 5000. Then, employing the total consumption of these components in the program to determine the Project 300 forecast for them did not constitute a detrimental factor. If in the future the BAF decides to use the ideas presented here, for the development of the kind of system being suggested, the items' consumption under the inspection

code 5000, which use is more adequate, will be promptly available.

Data About the Major Assemblies. The annual effort of the BAF's C-130 fleet varies between 800 and 850 hours per aircraft per year. A lower annual effort, 700 hours per aircraft per year, was used in the program as the starting point for computing the requirements of engines and propellers for the subsequent twelve month period. The average monthly consumption of the items being analyzed corresponds to a higher annual fleet effort (the real one of 800 hours per aircraft per year approximately). Consequently, the requirements for these items calculated through the dependent demand method (using only 700 hours per aircraft per year for the fleet effort) is expected to be about the same or inferior to the same items' demand predicted by the Project 300, which is based on their monthly average consumption. For this reason, the initial value of 700 hours per aircraft per year represents a neutral starting point from which the effects of variations in the fleet's effort could be evaluated. Using the real average annual effort of the C-130 fleet was not necessary, since the program's objective is not to select the best forecasting method, but only to show how the current Project 300 forecasting could be supplemented.

The size of the Brazilian Air Force's C-130 fleet was another value used to determine the annual demand for engines

and propellers. Currently, there are 15 aircraft in the fleet. Their tail numbers are listed on table 3 below:

Table 3
Tail Numbers of the BAF fleet of C-130

2451	2458	2463
2453	2459	2464
2454	2460	2465
2455	2461	2466
2456	2462	2467

The mean times between failures (MTBF) for the engine and propeller were obtained from the files of the BAF central depot for the C-130, on June 10, 1991, through a telephone call. They were calculated by that depot's Planning and Control Division using data available until the end of 1990. The MTBF for the engine, PN T56A15, is 3300 hours; and for the propeller, PN 54H60-117, it is 2711 hours. The option for the use of these two major items in the study of investigative question "b" was also partially due to their relative importance, in terms of price, among the repairable items applied in the C-130. Their high value makes them the object of greater attention in the maintenance and updating of statistics, which results in the availability of more reliable data related to them.

Description of the Program. The program was written in QUATTRO PRO, and it was intended to provide the basis of a process to compare the Project 300 forecasting technique's results to projections made through a dependent demand forecasting method, in order to demonstrate that the creation and adoption of such a method would represent a real advantage to the Brazilian Air Force's material planning system.

The program is able to utilize the hours scheduled to be flown by the C-130 fleet during a period of one year and the MTBF of its engines and propellers to estimate the future demand (in the following 12 months) of these two components. Based on these two factors, the program determines the quantity of dependent demand items required to support engine and propeller's depot maintenance level during the period under consideration. The formula used to calculate the number of engines and propellers needed is:

$$N = \frac{T}{M} \times Q_1 \tag{8}$$

Where:

N - Number of engines or propellers needed;

T - Total annual effort, in flying hours, for the C-130 fleet;

M - MTBF for the engine or propeller; and

Q_1 - Number of engines or propellers per aircraft.

The number of dependent demand items that should be ordered to perform depot level maintenance in these major assemblies was given by the formula below:

$$D = (N \times Q_2) - (S + C) \tag{9}$$

Where:

D - Quantity of dependent demand spare parts that should be ordered;

Q_2 - Quantity of each specific dependent demand spare part per NHA;

S - Available stock for the spare part being considered; and

C - Current credit (orders) for the spare part.

Then, the program compares these results with the forecast provided by the Project 300 for the same items. The two estimates can be observed together through printed reports, graphics and displays in the screen.

The program is menu-driven and it contains complementary notes at the bottom of the screen, for all the menu options. The user can change the following parameters:

a. Number of aircraft in the fleet;

b. Average hours to be flown per airplane;

c. Stock of engines and propellers; and

d. Number of spare engines and propellers.

The first three variables above are used to estimate dependent demand items requirements through formulas 8 and 9.

The last one serves only as an upper limit included in the program to prevent the user from entering a quantity in stock of a major component greater than the quantity of spare major components available in the project. The program is tailored to accept two NHA and up to 100 spare parts for each NHA. These items are sorted by part number and items presenting monthly average consumption greater than zero are copied to two work areas, in which they are linked to the calculation formulas and to the graph series. Besides that, it also presents the Project 300 forecast for the spare parts under study. That forecast is obtained by multiplying the Project 300 monthly average consumption for each spare part by 12.

Outputs Generation. The program produces several different types of outputs to serve as analysis tools. Following user's instructions, issued through menu options, the program may generate four different types of printed outputs. Report 1: Project 300 forecast compared to dependent demand (see Appendix J). This report constitutes the most significant printed output presented by the program. It provides a comparison between the requirements of the items being analyzed calculated by the Project 300 and the predictions of the same items provided by the dependent demand method. It includes the following information for each spare part: Project 300 forecast, quantity available (stock on hand plus credit), Project 300 balance (forecast minus quantity available), dependent demand forecast, and dependent demand balance (forecast minus quantity available).

Reports two, three, and four were created to provide the users with a more complete identification of the items being used in the program. They contain general information about them, such as quantity per NHA, monthly average consumption, name, and national stock number.

Screen Displays. The same data available on report 1 can be viewed on the screen. In order to build the screens, the program transfers the data to an output area, where they are arranged in portions compatible with screen dimensions. The fields included on report two, three and four are also accessible through the screen. The menu options available to the users, and displayed on the screen, as the program is run are comparison of forecasting methods and spare parts data summary.

Graphs. An easy way to observe the data displayed on report 1 is through the two different types of graphs provided by the program: Comparison of Forecasting Methods and Available Supply Compared to Demand.

The first one, Comparison of Forecasting Methods, puts together the forecasts produced by the Project 300 and the dependent method predictions related to the spare parts of a specific major assembly. As shown in Appendix J, figure 4, each number on the horizontal axis corresponds to a specific part number listed on report 1. For example, PN 6816058-2, an engine spare part, is the nineteenth record appearing on report 1, Appendix J, and corresponds to the point x = 19 on the graph illustrated on the same appendix, figure 4. The

values on the vertical axis represent the quantity of a specific part number required to perform depot level maintenance in the major assembly addressed by the graph, without considering the stock and credit available. These data appear on columns "P-300 Forecast" and "Dependent Demand" of report 1. For PN 6816058-1, the graph on Appendix J figure 4 shows that, Project 300 forecasted a requirement of 10 units, while the dependent demand method suggested that 13 units would be needed. Assuming all data to be accurate, if a real future fleet effort greater than the one reflected by the average monthly consumption registered in the Project 300 occurs, it is likely that the total stock forecasted by the Project 300 will be lower than the actual future demand, because the Project 300 forecast does not consider any input other than past consumption, and will lag whenever the fleet flies a number of hours above usual.

The second graph, Available Supply Compared to Demand, presents the results obtained after subtracting the existing stock on hand and credit from the quantities forecasted, shown on the first graph. Therefore, for each item being analyzed, the second graph displays suggestions of quantities to be ordered of spare parts from a specific major assembly produced by both methods (Project 300 and dependent demand) through formula number 9. This graph can be seen on Appendix J, figure 5. As previously mentioned in the description of the first graph, each number on the horizontal axis corresponds to a specific part number listed on report 1.

However, unlikely the first graph, the values on the vertical axis represent the quantity of a specific part number that should be ordered to perform depot level maintenance in the major assembly considered. These data appear on columns "P-300 Balance" and "Dependent Demand Balance" of report 1. For PN 6816058-2, this graph shows that Project 300 suggested that 4 units should be ordered (10 units, forecasted, minus 6 units, available, equals 4 units). For the same PN, the dependent demand method recommended a purchase of 7 units (13 units, forecasted, minus 6 units, available, equals 7 units). Assuming all data to be accurate, and a real fleet effort above average in the future, by the same reasons already mentioned in the description of the first graph, it is likely that the quantity ordered based only on past consumption, will not be enough to fulfill the actual future demand.

<u>Other Features</u>. The program leaves to the user the choice of saving the current set of data with the spreadsheet, while continue within the program environment. This means that users do not need to exit the program, in order to save the spreadsheet. Additionally, the users are provided with an optional brief orientation on the program's main features.

The menus' structure is presented in figure 3, on the next page.

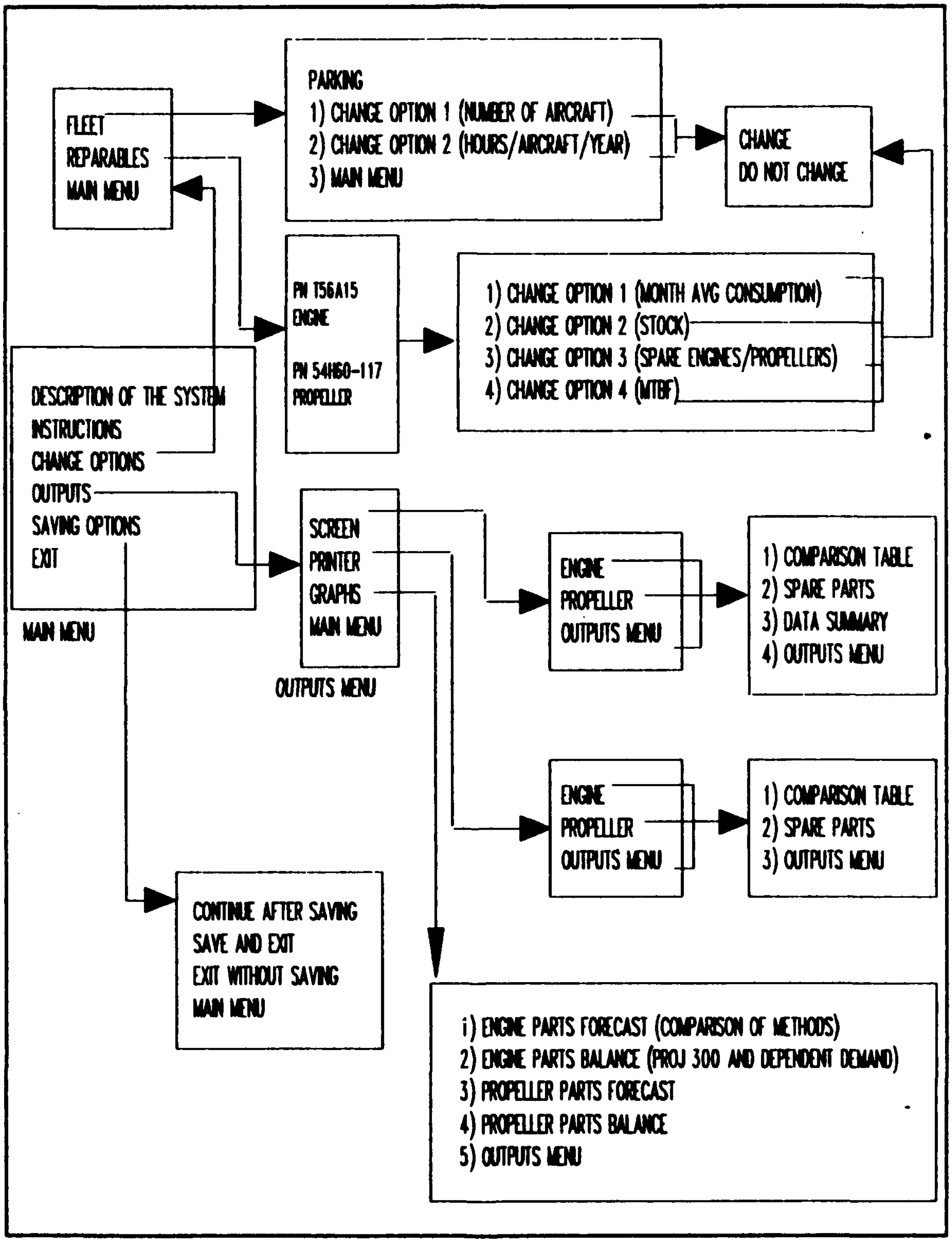

Figure 3. Menu Structure

IV. CONCLUSIONS

Investigative Question a: System's Reorganization With Partial Adoption of the Item Manager Concept

As mentioned previously (on page 33), reorganizing the system as proposed here would demand practically nothing in terms of resources commitment. The current system's structure and the existing software would remain useful; only management procedures would need adjustments, the personnel would need to go through a short training period to be informed of the new procedures and to assimilate them.

Results of Analysis of Items With the Same PN and NSN. Currently, as shown in Appendix D, it is possible to assure that there are 7515 different consumable items with individual PNs and NSNs in the Brazilian Air Force's inventory duplicated in more than one type of aircraft, that means being managed separately in different aircraft. Every time such an item appears in a project (aircraft), it accounts for one register, and the total number of registers corresponding to them is 19863. A complete list of them would take 125 pages approximately. By this reason only significant excerpts of this list, obtained with the DBASE III program transcribed in Appendix A are presented in Appendix B. If the administration of these items were centralized, 12348 (19863 minus 7515) registers (see Appendix

D) could be eliminated from the system (a project in the Brazilian Air Force contains 30000 items in the average. Then, this figure compares to approximately 41% of a project). As already mentioned, the data-file used in the conduction of this investigation contains only part numbers recorded in more than one project; that is, existing in two or more types of aircraft. The first figure, 7515, was assessed by computing each duplicated item with an individual PN and NSN only once, independently of the number of times it is repeated in the data-file. The second amount, 12348 registers likely to be canceled from the system, corresponds to the sum of the number of times that the same item with each individual PN and NSN was found in the system in different projects minus one. The ratio of 1.64 between these two figures permits to infer that each distinct item occurs in three different aircraft in the average. Considering that these groups of items have identical PN and NSN, they can be promptly considered as being the same material, without requiring further analysis in the field. Some of the benefits that would result immediately from adopting the item manager concept in accordance with the present proposal are:

a. Computer Processing Optimization. Despite being the same item, each part number common to two or more projects (aircraft) is treated individually in each of these projects. Thus, canceling 12348 records (each record corresponds to an item being managed in a project) implies that a proportional

amount of computer transactions will stop being processed in the monthly runs of the system. A significant reduction in the number of transactions per month would be realized, resulting in savings of computer processing time and computer memory space. The total decrease in quantity of transactions could be quantified by multiplying 12348 by the average number of transactions issued per active item in the system per month;

b. Decrease in the Number of Stock Locations. Each part number registered in a project requires a stock location at the Depot managing that aircraft. Distinct locations for the same item may occur at different Depots or at the same one, in case it is the central for more than one type of aircraft using the common item. Then, canceling 12348 records means reducing the same amount of stock locations, with considerable savings in storage space.

c. Decrease in the Number of Purchase Orders. Another benefit of the proposed modification would be the reduction of a very negative drawback of managing the material by aircraft: the generation of successive requisitions of identical low cost expendable items in small quantities. Sometimes the same item is ordered for different aircraft in the same run of the system. One of the improvements expected from adopting, even partially, the item manager concept is a decrease in the frequency of requisitions and an increase in the quantities ordered, since consumption in the various aircraft would be consolidated, and a single manager would

issue all requisitions for the same item. Appendix D shows that among the credits (requisitions) present in the system when the data-file was withdrawn, for items with the same PN and NSN registered in more than one type of aircraft, 173 credits would not exist if the common items were centrally administered. This figure represents the sum of the number of times that orders were found in different projects for any item among the 7515 ones with the same PN and NSN present in more than one type of aircraft minus one (that is, if the common items were centrally managed, there would be only one order in the system for each different item each time, because requirements for all projects using that item would be ordered together). In the Brazilian Air Force's inventory system, consumable items are ordered in quantities supposedly enough to cover needs for one year. Then, regularly consumed items are expected to be ordered once every year. Considering that the cost per order is $20, approximately $3460 per year in ordering costs would be saved if the proposed modification were adopted.

In the long run, besides savings in ordering costs, unitary prices are expected to decrease due to the placement of fewer larger orders instead of more frequent smaller ones, and transportation from vendor to depot, which includes international fees in most cases, would be optimized by the same reason. The transportation from depots to final users would not be affected, since only changes of depots and changes of material locations would occur.

d. Reduction in Direct Administrative Labor. Finally, due to managing the common items centrally, considerable savings in man-hours are expected. Currently, a different manager controls these items in each of the projects they are active, and employees are needed to handle the same items in the various warehouse where the stocks are distributed. If the modification being suggested, were implemented, only one manager would be needed per item, no matter the number of aircraft using it, and optimization of the work force in general would be achieved.

Results of Analysis of Items With Different PN, but the Same NSN. These results are shown in Appendix F. Currently there are 511 distinct groups of items in the system within which the PN is always different, the NSN is always the same, and the type of aircraft is always different, that means identical NSNs are being managed separately in different aircraft, however the PN assigned to these identical NSNs in each of the aircraft they are registered is different. Probably they could be used interchangeably. After a verification in the field to confirm this relationship and standardize their identification, they could be joined under the same depot's administration (the central for the common items), and one item from each group could be selected for preferential use. The other registers would not be canceled, but kept in the system as alternatives in case of difficulties with the selected item, such as future procurement problems. As a result, 532 registers would

remain in the system for reference only; that is, no transactions would be issued for them anymore. If one of them became preferred for use, another would take its place as reference. These figures were determined in the same way already described for the groups of items with the same PN and NSN, only the condition was changed. The benefits cited above would be increased in direct proportion to the quantity of items confirmed as interchangeable after the necessary verification.

Results of Analysis of Items With the Same PN, the Same CAGE, and Different NSN. These results are shown in Appendix H. Currently there are 4156 distinct groups of items in the system within which the PN is always the same, the CAGE is always the same, the NSN is always different, and the type of aircraft is always different. That means items with identical PNs and CAGEs are being managed separately in different aircraft; however the NSN assigned to them in each of the aircraft they are registered is different. In most of the cases, the part number and the manufacturer's code individualize completely a supply item; that is, normally the same manufacturers do not assign identical part numbers to the different items they build. Thus, the probability of these items being the same is high. Presumably, at the time they were registered in the system, in the diverse projects they are used in, their national stock numbers were assigned incorrectly. Further inspection is again necessary in this case to detect the correct NSN of such items and standardize

their identification, before considering them as the same. If this inspection confirmed all items within each of these 4156 diverse groups as the same, 4955 records (see Appendix H) could be canceled from the system. To determine these figures, the same procedure used in the previous cases was employed, with the conditions changed accordingly. The final increase in the benefits to the system already mentioned, resulting of the analysis of this last group of items likely joined under the administration of a single manager, depends on the results of the necessary review of their identifications.

Concluding, the initial benefits from transferring the management of the individual PNs and NSNs duplicated in the system to a single manager plus the addition in the magnitude of these benefits that would be gradually included as the analysis of each remaining group of items ended, completely justify the small amount of resources needed to implement the modification as suggested here.

Investigative Question b

As stated previously, the concern in investigative question b was to suggest the development of a method by the Brazilian Air Force, based on the dependent demand concept, that would be useful to automatically predict the requirements of consumable items needed by the depots to

perform their annual maintenance programs. To show the feasibility of creating such a system, the program in QUATTRO PRO, described in Chapter III, and shown on Appendix I was written. The program uses only dependent demand data already available in the Project 300, to compare requirements of some components of the C-130's engine and propeller predicted through the Project 300 traditional method, with requirements of the same items forecasted using the basic concepts that would be employed in the system which development is being proposed. This new method would not replace the Project 300 forecasting technique, but supplement it.

Results. Initially, in order to compare the outcomes provided by the Project 300 forecast with the ones yielded by the dependent demand method, the program was run for a fleet effort of 700 hours per aircraft per year. As mentioned previously, in the methodology chapter, it was necessary to find an equilibrium starting point in which the future demand of a given part number suggested by both the methods would be close to each other. This point should be around 800 hours per aircraft per year (the actual annual effort of the BAF's C-130 fleet). The rationale supporting this idea is that the Project 300 forecast is entirely based on the item average monthly consumption. Then, considering that the effort of the C-130 fleet has been 800 hours per aircraft per year lately, the current average monthly consumption registered in the system, as well as the forecasts it suggests should

conform to this fleet effort. In addition, it is important to recall that the dependent demand items studied were selected in accordance with indications contained in the report 35A of the Project 300, which lists all the dependent demand items of a major component. Furthermore, all data related to them, such as the quantity of spare part per major component, also come from the Project 300 (see the methodology chapter). Then, assuming all data to be accurate, it was expected that employing a value of 700 hours per aircraft per year in the program as a starting point, the dependent demand method would produce requirements of the selected engine and propeller's spare parts for the subsequent twelve month period inferior to the needs of the same items predicted by the Project 300, based on their average monthly consumption, which corresponds to 800 hours per aircraft per year.

The results obtained for the engines shop, in this first run, are illustrated on appendix J and figures 6 and 7 (refer to Chapter III - Methodology for graphs description). They show that even using a fleet effort below average, a factor that drives the dependent demand forecasts down, and the items' total average monthly consumption in the project, instead of their partial consumption under the inspection code 5000, a factor that drives the Project 300 forecast up, the predictions obtained through the dependent demand method are higher than the ones obtained with the Project 300 technique for all items. This departure of the results

anticipated for the engines shop shows an important possible application of the method being proposed: the average monthly consumption recorded in the Project 300 should be compatible with the average fleet effort, and the dependent demand data present in the Project 300 should be accurate. Then the requirements predicted by both methods, using a fleet effort below average in the dependent demand program, should be at least approximately the same. If the opposite occurs, as in this case, deviations in the planning and control process at the engines shop, such as failures in emitting Project 300 transactions responsible by feeding in the system data related to past consumption and dependent demand information, are likely to be revealed through an audit in that particular shop. All items exhibiting such discrepancies should be carefully analyzed, and the necessary adjustments made. Only after that, the suggestions from the dependent demand method related to them would be considered reliable. Then, an immediate benefit of creating the system being proposed would be the measurement of how accurate the information on dependent demand and past consumption currently existing in the Project 300 are. The new system and the Project 300 would complement each other, and a reliable basis for the adjustments deemed necessary, after examining each shop's results, would be provided.

Appendix K and figures 6 and 7, show the program's first run results, using a fleet effort of 700 hours per aircraft per year, for the propellers shop. As expected, the

forecasts determined through both methods were close for most of the items under the conditions established in this first run of the program.

After that, the program was run again with the number of hours to be flown per aircraft per year increased to 800. The results of this run are presented on Appendix L and figures 8 and 9 for the engines shop, and on Appendix M and figures 10 and 11 for the propellers shop. As shown on those attachments, increasing the number of flying hours per aircraft, implies in higher consumption of major assemblies, which results in an augment in the requirements of dependent demand consumable items, to be applied on their NHA repairs, occurring in greater number. As expected, the requirements of dependent demand items become much higher as the fleet effort is raised. Appendix N, figures 12 and 13; appendix O, figures 14 and 15; appendix P, figures 16, 17; and appendix Q, figures 18, 19; produced with the fleet effort fixed in 900 hours per aircraft per year, and in 1000 hours per aircraft per year, illustrate this tendency. The report 1 for the propellers shop (see Appendix O, figures 14 and 15), shows that with a fleet effort of 900 hours per aircraft per year, the difference between the requirements of propellers components predicted through the dependent demand method and the forecasts of the same items obtained with the Project 300, that practically did not exist with a fleet effort of 700 hours per aircraft per year, as shown in the first run of the program, is already more pronounced. The program still

supports other kinds of variations, such as reducing the fleet effort and altering the MTBF. Their results can be easily observed on screen displays, and including hard copies showing them as appendices was not judged necessary.

The results above demonstrate that the forecasts produced by the Project 300, based only on past consumption, are completely insensible to the factors influencing the requirements of dependent demand items. Considering the importance of this type of item to the depot's maintenance programs, and the likelihood of variations in the factors controlling their demand, the necessity of adding to the BAF logistics system the capabilities represented by such a tool is evidenced. Additionally, the new system would be very effective for the determination of material requirements under conditions other than the normal ones. For example in a situation of emergence, such as a conflict, that would demand a fleet effort much higher than at peace time, the determination of needs in terms of major components and consumable spare parts applicable in their overhaul would be easy and immediate if a system like the proposed one were available, and a reliable evaluation of the situation would be possible.

An other reason reinforcing the convenience of creating the proposed system is that the required dependent demand information is already available in the Project 300. This was also proved with the conceptual QUATTRO PRO program, that uses only spare parts' data coming from a Project 300 output,

the report 35A. The Project 300's mainframe module that produces that report would constitute the main input for the new system (bill of materials). Its previous availability is a decisive factor that reduces the expected cost for the development of the new system, and increases its feasibility. Only for the automatic determination of the MTBF, also a primary input needed by the new system, a mainframe module would have to be developed (the MTBF currently available at the depots are calculated through their domestic systems, not always the same in different depots, and using microcomputers).

In conclusion, the analysis of investigative b demonstrates that important breakthroughs would occur in the Brazilian Air Force's logistics, with the creation of the proposed system. It is necessary, and would be beneficial to supplement the Project 300. Finally its development is feasible, since most of the required data is already available.

Appendix A: DBASE III Program Employed to Display or Print, Partially or Totally, the Individual PNs and NSNs Duplicated in One or More Aircraft

```
* REPORT PROGRAM: R2A.PRG
* Application:   THESIS1
* Description:   With data screen
* Authors:       BOARETO / NELSON
* Software:      dBASE III plus
* Date:          06/02/91

PROCEDURE R2A

* DATABASE FILES
  dbf1       = 'D:\DIRMA\DIRMA1.DBF'
  alias1     = 'DIRMA1'
  ndx1       = 'D:\THPROG\PNNSN'
  driver_dbf = 'D:\DIRMA\DIRMA1.DBF'

* CONTROL VARIABLES
  bot_margin = 1
  max_width  = 80       && max characters in a line
  no_dbfs    = 1
  no_lookups = 0
  no_zooms   = 1
  pgftr_lins = 0
  prnt_lines = 60
  rcd_count  = 0
  rcs_on_pge = 0
  rcs_on_rpt = 0
  top_record = 0
  scrn_lines = 23
  top_margin = 1

* VARIABLES
  store 0 to count
  store 0 to nunrec
  store 0 to skiprec
  store 0 to numpage
  store 0 to firstrec

* ENVIRONMENT
  set bell off
  set confirm on
  set decimals to 10
  set deleted on
  set device to screen
  set echo off
  set exact off
  set heading off
  set margin to 1
```

```
  set safety off
  set scoreboard off
  set status off
  set talk off
* COLORS
  run_color = .F.
  if iscolor() .and. run_color
    box_clr   ='w+/b'
    help_clr  = 'r+/gr'
    messg_clr = 'gr'
    prmpt_clr ='gr+'
    stand_clr ='gr+/b,w+/b,b'
  else
    box_clr   = 'gr+/b,w+/b,b'
    help_clr  = 'gr+/b,w+/b,b'
    messg_clr = 'gr+/b,w+/b,b'
    prmpt_clr = 'gr+/b,w+/b,b'
    stand_clr = 'gr+/b,w+/b,b'
  endif

* DATABASE 1: DIRMA1
  * Field variables
  nsn = space(13)
  pn = space(18)
  proj = space(5)
  * Related variables
  lst_flds = "pn+' '+nsn+' '+proj"
  lst_flds = lst_flds + ;
        "+ '
'+iif(recno()=first_rec,'<','')+iif(recno()=last_rec,'>','')"
  lst_hdr = "PN                 NSN              PROJ "
  ndx_exp = 'pn + nsn'
  lnk_var1 = ''
  ndx_var1 = 'm->pn + m->nsn'

* WORK VARIABLES
  abort       = .F.
  at_eof      = 'eof()'
  at_top      = .F.
  beep        = chr(7)
  brk_no      = 1
  brk_num     = '1'
  choice      = ''
  done        = .F.
  done_cond   = '&ndx_exp >last_val.or.abort.or.eof()'
  files_ok    = .T.
  first_rec   = 0
  first_val   = ''
  last_rec    = 0
  last_val    = ''
  line_no     = 1
  lns_per_pg  = 0
  ndx_var     = ndx_var1
```

```
  option      = ''
  outp_dev    = ''
  page_no     = 1
  rec_count   = 0
  record_no   = 0
  zoom_no     = 1
  zoom_num    = '1'
  donecond1   = 'abort.or.eof()'

* SCREEN
  clear
  set color to &stand_clr
  do disscr

* OPEN FILES
  do chkfil
  if .not. files_ok
    return
  endif
  select 1
 use D:\DIRMA\DIRMA1 index D:\THPROG\PNNSN
    set filter to code = 1
      go top
  if eof()
    do disp_msg with beep + 'No data'
    close databases
    return
  endif

* INITIALIZE SCOPE
  go bottom
  last_rec = recno()
  last_val = &ndx_exp
  go top
  first_rec = recno()
  first_val = &ndx_exp
  record_no = recno()

* PROCESSING LOOP
  do while option <> 'Q'
    set color to &stand_clr
    select 1
    record_no = recno()
    * Load and display the current record
    do load
    do getfld
    do dis_stat
    option = 'G'
    do get_optn with ;

'Go/</>/Begin/End/Next/Prev/Skip/List/Tally/Report_thesis/Hel
p/Quit',;
          'G<>FBENPSLTRHQ', option
```

```
    do case
* < (set first record)
      case option = '<'
        if &ndx_exp <= last_val
          first_rec = recno()
          first_val = &ndx_exp
        else
          do disp_msg with "First record must precede the
last record"
        endif
* > (set last record)
      case option = '>'
        if &ndx_exp >= first_val
          last_rec = recno()
          last_val = &ndx_exp
        else
          do disp_msg with "Last record must follow the first
record"
        endif
* Beginning
      case option = 'B'
        go top
* End
      case option = 'E'
        go bottom
* Go print/display the report
      case option = 'G'
        clear
        set color to &stand_clr
        do get_dvce
        if outp_dev <> 'Q'
          do init_rpt
          do rpthdr
          do pgehdr
          do rptbdy
          do rptftr
          line_no = lns_per_pg
          do pgeftrl
          do end_rpt
        endif
        go first_rec
* Help
      case option = 'H'
        set color to &help_clr
        do rep_help
        set color to &stand_clr
        do disscr
* List
      case option = 'L'
        if .not. '' = lst_hdr
          do list with lst_flds, lst_hdr
          go record_no
          do disscr
```

```
        else

          do disp_msg with 'Screen has no list fields'
        endif
* Next
      case option = 'N'
        skip
        if eof()
          go bottom
          do disp_msg with 'Last record'
        endif
* Previous
      case option = 'P'
        skip -1
        if bof()
          go top
          do disp_msg with 'First record'
        endif

* Report
*  investigative question A; print/display the report
   case option = 'R'
    clear
    set color to &stand_clr
*Input print parameter
    * Draw a screen box
    @ 1,0 to 22,79 double
    @ 3,1 to 3 ,78
    @ 2,10 say 'Investigative Question A - Report Generation'
    @ 7,10 say ' This program will print/display'
    @ 8,10 say ' x records and skip y records'
    @ 9,10 say ' while not EOF condition is true.'
    @ 11,10 say ' Please, indicate: '
    do while nunrec <= 0
    @ 12,10 say ' Number of records (x) to print?' get nunrec
picture '@Z 999'
    read
    enddo
    do while skiprec <= 0
    @ 13,10 say ' Number of records (y) to skip?' get skiprec
picture '@Z 99999'
    read
    enddo
    do while numpage <= 0
    @ 14,10 say ' Report should start on page?' get numpage
picture '@Z 999'
    read
    enddo
    do while firstrec <= 0
    @ 15,10 say ' How many to skip before start?' get
firstrec picture '@Z 99999'
    read
    enddo
```

```
  clear
  set color to &stand_clr
        do get_dvce
        if outp_dev <> 'Q'
         if outp_dev <> 'P'
          do init_rpt
         else
          do initrptl
         endif
          do rpthdr
          do pgehdr
          do rptbdyl
         if outp_dev = 'P'
          line_no = 59
          do pgeftr
          @ 63,33 say ' '
         else
          line_no = lns_per_pg
          do pgeftrl
         endif
          do rptftr
          do end_rpt
        endif
        go first_rec
        store 0 to count
        store 0 to nunrec
        store 0 to skiprec
        store 0 to numpage
        store 0 to firstrec

*Skip
  case option = 'S'
        * Move forward/backward several records
        rec_count = 0
        @ 23,66 say '  Recs' get rec_count picture '@Z 9999'
        read
        skip rec_count
        if &at_eof
          go bottom
          do disp_msg with 'Last Record'
        endif
        if bof()
         go top
         do disp_msg with 'First record'
        endif
        rec_no=recno()

    * Tally
      case option = 'T'
        * Count and display number of records in database
        @ 23,00
        @ 23,00 say 'Counting, please wait'
        rec_count = 0
```

```
        go top
        count while .not. &at_eof to rec_count
        do disp_msg with 'Count: ' + str(rec_count,6) + '
records'
        go record_no
    endcase
  enddo

  close databases
return

* SPECIFIC PROCEDURES

procedure chkfil
* Verify that all the database files accessed by the program
exist.
* If a database file is missing, set files_ok to .F. and
display a message.
* If they all exist, check their index files, and create any
that is missing.
  close databases
  if .not. file ('D:\DIRMA\DIRMA1.DBF')
    do disp_msg with 'File DIRMA1.DBF not found in drive d:'
    files_ok = .F.
  endif
  * Index if index file missing
  if files_ok
    if .not. file ('d:\THPROG\PNNSN.NDX')
      @ 23,00
      @ 23,00 say 'Creating index PNNSN'
      use D:\DIRMA\DIRMA1.DBF
      index on pn + nsn to D:\THPROG\PNNSN
      use
    endif
  endif
return

procedure clrfld
* Clear screen fields and field areas
  @ 7,5 say space(18)
  pn = space(18)
  @ 7,29 say space(13)
  nsn = space(13)
  @ 7,53 say space(8)
  proj = space(5)
  set color to &stand_clr
return

procedure detail
* Compute and display report detail information
  if abort
    return
  endif
```

```
  if line_no = lns_per_pg
   if outp_dev = "S"
    do pgeftrl
   else
     do pgeftr
   endif
    do adv_page
  endif
  @ line_no,8 say DIRMA1->pn
  @ line_no,34 say DIRMA1->nsn
  @ line_no,61 say DIRMA1->proj
  do adv_line
  if outp_dev = "S"
  endif
  rcs_on_pge = rcs_on_pge + 1
  rcs_on_rpt = rcs_on_rpt + 1
return

procedure disscr
* Display stationary part of the report screen
  clear
  set color to &stand_clr
  @ 1,0 to 22,79 double
  @  4, 6 say 'PART NUMBER                 NSN
AIRCRAFT'
 return

procedure getfld
* Get field variables
  @ 7, 5 get m->pn
  @ 7, 29 get m->nsn
  @ 7, 53 get m->proj
  clear gets
return

procedure load
* Copy fields from database record to memory variables
  pn = pn
  nsn = nsn
  proj = proj
return

procedure pgeftr
* Print page footer
  if abort
    return
  endif
   line_no = line_no + 2
    @ line_no,33 say page_no
    line_no = line_no + 1
  rcd_count = rcs_on_pge
  rcs_on_pge = 0
return
```

```
procedure pgeftrl
* Print page footer for option G and for screen display
  if abort
    return
  endif
  rcd_count = rcs_on_pge
  rcs_on_pge = 0
return

procedure pgehdr
* Page header (don't use procedure adv_line here!)
    line_no = line_no + 2
    @ line_no,08 say "PART NUMBER          NATIONAL STOCK
NUMBER        AIRCRAFT"
    line_no = line_no + 2
return
procedure pgehdrl
* Page header (don't use procedure adv_line here!)
    line_no = line_no + 6
    @ line_no,08 say "PART NUMBER          NATIONAL STOCK
NUMBER        AIRCRAFT"
    line_no = line_no + 2
return

procedure rptbdy
* Print report body
  do while .not. done
    do detail
    if .not. eof()
      skip
    endif
    done = &done_cond
  enddo
  skip -1
return

procedure rptbdyl
* Print report body for investigative question A
  do while .not. done
  store 0 to count
     do while count < nunrec
        store count+1 to count
        do detail
        if .not. eof()
           skip
           done = &done_cond
           do while (len(trim(nsn)) < 13) .and. .not. done
             if .not. eof()
              skip
             endif
           enddo
        endif
     enddo
```

```
      line_no = line_no + 1
      skip   skiprec
      done = &done_cond
      do while len(trim(nsn)) < 13 .and. .not. done
        if .not. eof()
          skip
        endif
      enddo
         if &at_eof
           go bottom
           skip -1
           return
         endif
    enddo
    skip -1
return


procedure rptftr
* Print report footer
     rcd_count = rcs_on_rpt
     rcs_on_rpt = 0
return

procedure rpthdr
* Initialize report variables and print report header
  line_no = line_no + 6
  @ line_no,13 say "Appendix B: List of Items With Identical
PN and NSN"
  do adv_line
  @ line_no,23 say "Used in More than One Aircraft"
  do adv_line
return

* GENERIC PROCEDURE
procedure adv_line
* Advance a report/screen line
  line_no = line_no + 1
  if line_no = lns_per_pg
   if outp_dev = "S"
    do pgeftrl
   else
     do pgeftr
   endif
    do adv_page
  endif
  abort = iif (inkey() = 6, .T., abort )   && End key
  at_top = .F.
return

procedure adv_page
* Advance report/screen page
  page_no = page_no + 1
```

```
  if outp_dev <> 'P'
    choice = 'Y'
    do get_optn with 'More (Y/N)', 'YN', choice
    if choice = 'N'
      abort = .T.
    endif
    clear
    line_no = 0
    do pgehdr
  else
    eject
    line_no = top_margin
    do pgehdrl
  endif
return

procedure chng_brk
Parameters up
* Increment break level if "up" = .T., decrement otherwise
  if up
    * Set new report termination condition
    brk_field = brk_field&brk_num
    new_cond = '&brk_field<>m->&brk_field' + '.or.'
    cond_size&brk_num = len(new_cond)
    done_cond = new_cond + done_cond
    * Store break field to memory variable
    &brk_field = &brk_field
    * Zoom up if it is a "zoom" break
    if brk_zoom&brk_num
      zoom_no = zoom_no + 1
      zoom_num = str(zoom_no,1)
      frst_child = lnk_var&zoom_num
      select &zoom_num
      seek &frst_child
    endif
    * Increment break number
    brk_no = brk_no + 1
    brk_num = str(brk_no,1)
    done = &done_cond
  else
    brk_no = brk_no - 1
    brk_num = str(brk_no,1)
    * Reduce the report termination condition
    done_cond = substr(done_cond, 1+cond_size&brk_num)
    * Zoom down if it is a "zoom" break
    if brk_zoom&brk_num
      zoom_no = zoom_no - 1
      zoom_num = str(zoom_no,1)
      select &zoom_num
    endif
  endif
return
```

```
procedure dis_stat
* Display report scope
  @ 20,15 say space(64)
  @ 20,2 say 'First Record < ' + first_val
  @ 21,15 say space(64)
  @ 21,2 say 'Last  Record > ' + last_val
return
procedure disp_msg
parameters message
* Display MESSAGE + '...' at line 23; wait for entry of any
key
* if MESSAGE is blank, make it 'Press any key to continue'
  @ 23,0
  @ 22,0 say ''
* set color to &msg_clr
  if '' = trim(message)
    wait message + 'Press any key to continue...'
  else
    wait message + '...'
  endif
* set color to &std_clr
  @ 23,0
return

procedure end_rpt
* Close a report
  if outp_dev <> 'P'
    if .not. abort
      do disp_msg with ''
    endif
    do disscr
  else
    eject
    set device to screen
  endif
return

procedure get_dvce
* Get user-selected output device for report
  * Draw a screen box
      @ 1,0 to 22,79 double
      @ 3,1 to 3 ,78
  if max_width <= 80
    outp_dev = 'S'
    do get_optn with 'Printer/Screen/Quit', 'PSQ', outp_dev
  else
    outp_dev = 'P'
  endif
  if outp_dev = 'P'
    lns_per_pg = prnt_lines - bot_margin - pgftr_lins
    choice = 'N'
    do get_optn with 'Printer ready', 'YN', choice
    if choice = 'N'
```

```
      outp_dev = 'Q'
    endif
  else
    lns_per_pg = scrn_lines - pgftr_lins
  endif
return

procedure get_optn
parameters optn_msg, optn_list, optn_ret
* Display the string optn_msg on line 23; get a character
(defaulted to
* to optn_ret, which must be a memory variable, not literal),
validate it
* against the list of valid options optn_list and return in
optn_ret.
* If optn_ret = 'A' display it without accepting (for forced
Add).
* PgUp and PgDn keys return '-' and '+', respectively; Esc
key returns 'Q'.
  @ 23,00 say optn_msg + '? '
  @ 23,len(optn_msg)+3
  char = ' '
  do while .not. char $ optn_list + '+-'
    char = optn_ret
    @ 23,len(optn_msg) + 2 get char picture '!'
    if optn_ret <> 'A'
      read
      char = iif (readkey() = 12, 'Q', char)
      char = iif (readkey() = 6,  '-', char)
      char = iif (readkey() = 7,  '+', char)
    else
      clear gets
    endif
  enddo
  optn_ret = char
return

procedure init_rpt
* Initialize a report
  page_no = 1
  if outp_dev = 'P'
    line_no = top_margin
    @ 23,0
    @ 23,0 say 'Printing; press End to stop printing'
    set device to print
  else
    line_no = 0
    clear
  endif
  lnk_var = ''
  abort = .F.
  go first_rec
  if option = 'R'
```

```
    skip firstrec
     do while (len(trim(nsn)) < 13) .and. .not. done
        skip
     enddo
  endif
  brk_no = 1
  brk_num = '1'
  done = &done_cond
  at_top = .T.
return
procedure list
parameters lst_flds, header
* Displays lst_flds beginning from current record, with
header
  do while .T.
    clear
    ? ' ' + header
    list off next 20 &lst_flds while .not. &at_eof
    if &at_eof
      do disp_msg with ''
      exit
    endif
    choice = 'Y'
    do get_optn with 'More (Y/N)', 'YN', choice
    if choice = 'N'
      exit
    endif
  enddo
return

procedure initrptl
* Initialize report for investigative question A
  if outp_dev = 'P'
    page_no = numpage
    line_no = top_margin
* Draw a screen box
  @ 1,0 to 22,79 double
  @ 3,1 to 3 ,78
    @ 23,0
    @ 23,0 say 'Printing; press End to stop printing'
    set device to print
  else
    line_no = 0
    clear
  endif
  lnk_var = ''
  abort = .F.
  go first_rec
  if option = 'R'
     skip firstrec
      do while (len(trim(nsn)) < 13) .and. .not. done
         skip
      enddo
```

```
  endif
  brk_no = 1
  brk_num = '1'
  done = &donecond1
  at_top = .T.
return
procedure list
parameters lst_flds, header
* Displays lst_flds beginning from current record, with
header
  do while .T.
    clear
    ? ' ' + header
    list off next 20 &lst_flds while .not. &at_eof
    if &at_eof
      do disp_msg with ''
      exit
    endif
    choice = 'Y'
    do get_optn with 'More (Y/N)', 'YN', choice
    if choice = 'N'
      exit
    endif
  enddo
return

 procedure rep_help
 * Display generic report help
  clear
  @ 06,00
  text
    <   ...........Set displayed record as the first one in
the report
    >   ...........Set displayed record as the last one in
the report
    Beg ...........Go to the first record in the driver
databas
    End ...........Go to the last record in the driver
database
    Go  ...........Print or display the report
    List...........Display driver records beginning from
current one
    Next...........Go to the next record in the driver
database
    Prev...........Go to the previous record in the driver
database
    Quit...........Exit the report program
    Report_thesis..Print or display report for investigative
question A
    Skip...........Go forward/backward by a number of records
    End key........Stop printing the report (pressed while
printing)
    Esc key........Exit the report program (same as Quit)
```

```
  endtext
  do scr_box with 'Help', 'Report Options'
  choice = 'Y'
  do get_optn with 'More (Y/N)', 'YN', choice
  if choice = 'N'
    return
  endif
  clear
  @ 06,00
  text
                  Key             Screen editing action
                  _________       _____________________

                  -->             Character right
                  <--             Character left
                  up arrow        Previous field
                  down arrow      Next field
                  PgDn, PgUp      Accept screen
                  End             Next word/field
                  Home            Previous word/field
                  Del             Delete character
                  Ins             Insert on/off toggle
                  Esc             Abort screen edit
  endtext
  do scr_box with 'Help', 'Screen Edit Keys'
  do disp_msg with ''
  clear
return

procedure scr_box
parameters l_title, r_title
* Draw a screen box with left title "l_title" and right title
"r_title"
  set color to &stand_clr
  @ 1,0 to 22,79 double
  @ 3,1 to 3 ,78
  @ 2, 2 say trim(l_title)
  @ 2, 78-len(trim(r_title)) say trim(r_title)
return

* EOF R2.PRG
```

Appendix B: Significant Excerpts of the List of Individual Part Numbers and National Stock Numbers Duplicated in One or More Types of Aircraft

PART NUMBER	NATIONAL STOCK NUMBER	AIRCRAFT
11141-0002	5905011272916	C-130
11141-0002	5905011272916	KC-137
11160-0010	5905010471536	C-115
11160-0010	5905010471536	C-130
1116133	5970009468195	P-16
1116133	5970009468195	C-130
1117718-1	5905008732651	UFT
1117718-1	5905008732651	R-35A
1117718-1	5905008732651	P-16
1117718-1	5905008732651	C-130
1118091	6125009998327	AT-26
1118091	6125009998327	UH-1H
11184	6610010073751	C-130
11184	6610010073751	F-5
1118561	3110008847372	UFT
1118561	3110008847372	C-130
1118562	6115008847373	C-130
1118562	6115008847373	UFT
1118588-5	5961008923195	R-35A
1118588-5	5961008923195	P-16
351-8598-012	5962011128587	CH-34
351-8598-012	5962011128587	C-95
351-8603-012	5962011308654	C-95
351-8603-012	5962011308654	CH-34
351-8748-012	5962011283920	C-95
351-8748-012	5962011283920	CH-34
351-8748-022	5962011283921	C-95
351-8748-022	5962011283921	CH-34
351-8756-012	5962011283922	CH-34
351-8756-012	5962011283922	C-95
3510	5945002644193	C-95
3510	5945002644193	UFT

3519-12	1560006268541	F-5
3519-12	1560006268541	P-16
3519-12	1560006268541	UH-1H
352-0009-000	5961007295616	VU-93
352-0009-000	5961007295616	C-95
352-0009-000	5961007295616	C-130
744257D1	5340010375299	C-95
744257D1	5340010375299	F-5
744257D2	5365010290295	VC-97
744257D2	5365010290295	C-95
74435	5330000384345	C-130
74435	5330000384345	UFT
744350	5935007827707	C-130
744350	5935007827707	UH-1H
74455061024	5305010160701	C-115
74455061024	5305010160701	F-5
744588-21	3110002517265	F-5
744588-21	3110002517265	VU-93
745-0677-000	5905000709329	VC-97
745-0677-000	5905000709329	UH-1H
745-0677-000	5905000709329	T-27
745-0677-000	5905000709329	C-95
745-0677-000	5905000709329	AT-26
745-0680-000	5905001393087	VC-96
745-0680-000	5905001393087	UH-1H
AN500-416-12	5305001511561	T-25
AN500-416-12	5305001511561	U-42
AN500-416-12	5305001511561	UFT
AN500-6-6	5305006162529	UFT
AN500-6-6	5305006162529	UH-1H
AN500-6-7	5305000131894	F-103
AN500-6-7	5305000131894	SPGRL
AN500-6-8	5035001513055	T-25
AN500-6-8	5035001513055	C-115
AN500-8-10	5305006229476	F-5
AN500-8-10	5305006229476	P-16
AN500-8-10	5305006229476	SPGRL
AN500-8-12	5305006602625	T-25
AN500-8-12	5305006602625	P-16

AN500-8-18	5305001512940	P-16
AN500-8-18	5305001512940	C-130
AN500-8-5	5305001512948	P-16
AN500-8-5	5305001512948	T-25
DG2A	5945004023914	C-130
DG2A	5945004023914	P-16
DG36	5325142777602	CH-55
DG36	5325142777602	UH-50
DG508ABK	5962012201507	VC-97
DG508ABK	5962012201507	VC-96
DG508ABK	5962012201507	R-35A
DG508ABK	5962012201507	KC-137
DG508ABK	5962012201507	C-95
DHS271-111-11	5970143032909	UH-50
DHS271-111-11	5970143032909	CH-55
DHS285-111-01	9330143677157	CH-55
DHS285-111-01	9330143677157	UH-50
DHS433-151-03	5310142367514	CH-34
DHS433-151-03	5310142367514	CH-55
DHS433-151-03	5310142367514	UH-50
DHS439-111-22	5310143981285	CH-55
DHS439-111-22	5310143981285	UH-50
MS24400D6	5310006382605	UFT
MS24400D6	5310006382605	UH-1H
MS24402D4	4730007221207	AM-X
MS24402D4	4730007221207	C-98
MS24402D4	4730007221207	T-27
MS24402D4	4730007221207	UH-1H
MS24402D5	4730000801854	C-130
MS24402D5	4730000801854	T-27
MS24456-2	5930009367567	P-16
MS24456-2	5930009367567	F-5
MS24465-4	3110002272822	C-130
MS24465-4	3110002272822	KC-137
MS24478-2	6685005575317	AM-X
MS24478-2	6685005575317	C-130
MS24482-1	6685005573786	U-19
MS24482-1	6685005573786	T-25

MS24482-1	6685005573786	P-16
MS24482-1	6685005573786	H-13H
MS24484-2	1560009492087	C-130
MS24484-2	1560009492087	F-5
RCR20G332JS	5905001048348	C-130
RCR20G332JS	5905001048348	C-95
RCR20G332JS	5905001048348	F-5
RCR20G332JS	5905001048348	P-16
RCR20G332JS	5905001048348	VC-96
RCR20G333JS	5905001048330	UH-1H
RCR20G333JS	5905001048330	P-16
RCR20G333JS	5905001048330	F-5
RCR20G334JS	5905001048346	C-130
RCR20G334JS	5905001048346	P-16
RCR20G361JS	5905001168562	C-130
RCR20G361JS	5905001168562	C-95
RCR20G361JS	5905001168562	F-5
RCR20G362JS	5905001145425	UH-1H
RCR20G362JS	5905001145425	P-16
RCR20G362JS	5905001145425	F-5
RCR20G362JS	5905001145425	C-130
RCR20G391JS	5905001114742	UH-1H
RCR20G391JS	5905001114742	P-16
RCR20G391JS	5905001114742	C-130

Appendix C: DBASE III Program Employed to Analyze the Items With the Same PN and the Same NSN

```
* Application:  THESIS
* Description:  INVESTIGATIVE QUESTION A, PART A
* Author:       Maj BOARETO / Maj NELSON
* Software:     BASE III plus
* PROGRAM: AGERAL1.PRG
* Program Objectives:
* 1. Place an identical code (1) in the data base field
*    "code" for all items with identical PN and NSN, present
*    in two or more types of aircraft;
* 2. Print a list of the items satisfying the conditions
*    specified in "1" above;
* 3. Count the common items (items with identical PN and NSN
*    present in two or more types of aircraft, and print the
*    total quantity;
* 4. Count the number of registers that could be eliminated
*    from the system, and print the total quantity;
* 5. Count the number of requisitions for items with
*    identical PN and NSN, present in the system when the
*    data base was generated, that would not exist if common
*    items were centrally managed, and print the total
*    quantity.
* PROCEDURE A
* ENVIRONMENT
*
CLEAR
set decimals to 10
set deleted on
set safety off
SET DEVICE TO SCREEN
SET BELL OFF
SET TALK OFF
SET EXACT ON
SELECT A
USE D:\DIRMA\DIRMA1 INDEX D:\THPROG\PNNSN
GO TOP
@ 1,10 SAY "A STUDY TO IMPROVE THE BRAZILIAN AIR FORCE"
@ 2,10 SAY "INVENTORY CONTROL SYSTEM"
@ 5,10 SAY "BEGINNING PROC A"
@ 6,10 SAY "ESTIMATED RUN TIME 20 MINUTES (386 SYSTEM)"
REPLACE CODE WITH 0 FOR CODE>0
@ 12,10 SAY "FIELD CODE SET TO ZERO"
GO TOP
STORE 0 TO COUNTER
@ 13,10 SAY "TOTAL QUANTITY OF COMMON ITEMS"
@ 14,10 SAY "(ITEMS WITH IDENTICAL PN AND NSN)"
@ 15,10 SAY "PRESENT IN TWO OR MORE TYPES OF AIRCRAFT:"
DO WHILE .NOT. EOF()
 STORE PN TO PN1
```

```
 STORE NSN TO NSN1
 SKIP 1
 IF .NOT. EOF()
    STORE PN TO PN2
    STORE NSN TO NSN2
    SKIP 1
 ENDIF
 IF .NOT. EOF()
    STORE PN TO PN3
    STORE NSN TO NSN3
 ENDIF
 IF PN1=PN2 .AND. NSN1=NSN2
      SKIP -2
      COUNTER=COUNTER+1
      REPLACE CODE WITH 1
      SKIP 1
      REPLACE CODE WITH 1
      @ 16,10 SAY COUNTER
      SKIP 1
    DO WHILE PN3=PN2 .AND. NSN3=NSN2 .AND. .NOT. EOF()
       IF .NOT. EOF()
         REPLACE CODE WITH 1
         SKIP 1
       ENDIF
       IF .NOT. EOF()
         STORE PN TO PN3
         STORE NSN TO NSN3
       ENDIF
    ENDDO
 ENDIF
 IF PN1 <> PN2 .OR. NSN1<>NSN2
  IF .NOT. EOF()
    SKIP -1
  ENDIF
 ENDIF
ENDDO
* This procedure places the digit "1" in the field code
* for each identical item (items with the same PN and
* NSN) present in two or more types of aircraft, and counts
* them.
*
*Program a:a2a3.prg
* Number of P/N and requisitions that could be eliminated
* from the system
CLEAR
USE D:\DIRMA\DIRMA1 INDEX D:\THPROG\PNNSNREQ
GO TOP
@ 1,10 SAY  "A STUDY TO IMPROVE THE BRAZILIAN AIR FORCE"
@ 2,10 SAY  "INVENTORY CONTROL SYSTEM"
@ 5,10 SAY  "BEGINNING PROC A2A3"
@ 6,10 SAY  "ESTIMATED RUN TIME 15 MINUTES (386 SYSTEM)"
@ 10,10 SAY "BEGINNING TO PROCESS"
```

```
STORE 0 TO COUNT1
STORE 0 TO COUNT2

@ 13,10 SAY "TOTAL QUANTITY OF REGISTERS THAT COULD"
@ 14,10 SAY "BE CANCELED FROM THE SYSTEM:"
@ 17,10 SAY "NUMBER OF REQUISITIONS THAT WOULD NOT"
@ 18,10 SAY "BE ACTIVE IN THE SYSTEM"
DO WHILE .NOT. EOF()
   STORE PN TO PN1
   STORE NSN TO NSN1
   STORE Q_REQ TO Q_REQ1
   SKIP 1
   IF .NOT. EOF()
      STORE PN TO PN2
      STORE NSN TO NSN2
      STORE Q_REQ TO Q_REQ2
   ENDIF
   IF PN1=PN2 .AND. NSN1=NSN2
      STORE COUNT1+1 TO COUNT1
      @ 15,10 SAY COUNT1
      IF Q_REQ1='1' .AND. Q_REQ2='1'
         STORE COUNT2+1 TO COUNT2
         @ 19,10 SAY COUNT2
      ENDIF
   ENDIF
ENDDO
* PROCEDURE A2A3
* OBJECTIVE 1. COUNT NUMBER OF PN THAT COULD BE
* CANCELED FROM THE SYSTEM
* OBJECTIVE 2. COUNT NUMBER OF REQ THAT COULD BE CANCELLED
* FROM THE SYSTEM.
* REPORT PROGRAM: OUTPUT INVESTIGATIVE QUESTION A, PART A
* Description:    APPENDIX C
* VARIABLES
* ENVIRONMENT
  CLEAR
  set heading off
  set margin to 1
  set scoreboard off
  set device to print
* Go print/display the report
@ 5,10  SAY "Analysis Results for Items With the Same PN and
NSN"
@ 10,10 SAY "Total quantity of items with identical PN and
NSN, used"
@ 11,10 SAY "in more than one type of aircraft:
@ 12,10 SAY "("
@ 12,11 SAY  m->counter picture '999999'
@ 12,17 SAY ")"
@ 16,10 SAY "Total quantity of registers that could be
cancelled from"
@ 17,10 SAY "the system:
@ 18,10 SAY "("
```

```
@ 18,11 SAY " m->count1 picture '999999'
@ 18,17 SAY ")"
@ 22,10 SAY "Total quantity of requisitions for items with
identical"
@ 23,10 SAY "PN and NSN that would not exist in the system
if common"
@ 24,10 SAY "items were centrally managed:
@ 25,10 SAY "("
@ 25,11 SAY m->count2 picture '999999'
@ 25,17 SAY ")"
eject
set device to screen
SET EXACT ON
SET SCOREBOARD ON
* EOF AGERAL1.PRG
```

Appendix D: Analysis of Results for Items With the Same PN and the Same NSN

Total quantity of items with the same PN and NSN, duplicated in one or more types of aircraft:
7515

Total quantity of registers corresponding to individual items with specific PN and NSN repeated in more than one type of aircraft, that could be canceled from the system:
12348

Total quantity of different requisitions for items with the same PN and NSN present in more than one type of aircraft, that were being processed in the supply system when the data-file was withdrawn, and would not exist in the system if common items were centrally managed:
173

Appendix E: DBASE III Program employed to Analyze the Items With the Same NSN and Different PN

```
* Application:  THESIS
* Description:  INVESTIGATIVE QUESTION A, PART B
* Author:       Maj BOARETO / Maj NELSON
* Software:     dBASE III plus
* Program "B1.PRG"
* Program objectives:
* 1. Place an identical code (2) in the data base field
*    "code1" for all items with identical NSN and different
*    PN present in two or more aircraft;
* 2. Print a list of the items satisfying the conditions
*    specified in "1" above;
* 3. Count the number of items with the same NSN and
*    different PN present in two or more aircraft, and print
*    the total quantity;
* 4. Count the number of registers corresponding to items
*    with identical NSN and different PN, present in more
*    than one aircraft that would remain in the system for
*    reference only; and
* 5. Count the number of requisitions for items with
*    identical
*    NSN and different PN present in the system when the
*    data
*    base file was generated, that would not exist if common
*    items were centrally managed, and prints the total
*    quantity.
*
CLEAR
SET TALK OFF
SET EXACT ON
USE D:\DIRMA\DIRMA1 INDEX D:\THPROG\NSNPN
GO TOP
@ 10,10 SAY "INITIALIZING FIELD CODE1"
REPLACE CODE1 WITH 0 FOR CODE1<>0
@ 12,10 SAY "FIELD CODE1 SET TO ZERO"
 SET FILTER TO LEN(TRIM(NSN))=13
 GO TOP
STORE 0 TO COUNT3
@ 14,10 SAY "TOTAL QUANTITY OF ITEMS WITH IDENTICAL"
@ 15,10 SAY "NSN AND DIFFERENT PN PRESENT IN TWO OR"
@ 16,10 SAY "MORE TYPES OF AIRCRAFT:"
DO WHILE .NOT. EOF()
 STORE NSN TO NSN1
 STORE PN TO PN1
 SKIP 1
 IF .NOT. EOF()
    STORE NSN TO NSN2
    STORE PN TO PN2
    SKIP 1
```

```
 ENDIF
 IF .NOT. EOF()
    STORE NSN TO NSN3
    STORE PN TO PN3
 ENDIF
 IF NSN1=NSN2 .AND. PN1<>PN2
      SKIP -2
      COUNT3=COUNT3+1
      REPLACE CODE1 WITH 2
      SKIP 1
      REPLACE CODE1 WITH 2
      @ 17,10 SAY COUNT3
        SKIP 1
    DO WHILE NSN3=NSN2 .AND. PN3<>PN2 .AND. NOT EOF()
       IF .NOT. EOF()
        REPLACE CODE1 WITH 2
        SKIP 1
       ENDIF
          STORE NSN TO NSN3
          STORE PN TO PN3
    ENDDO
 ENDIF
   IF NSN1<>NSN2 .OR. PN1=PN2
      IF .NOT. EOF()
        SKIP -1
      ENDIF
   ENDIF
ENDDO
*  This program places an identical code (2) in the field
*  code1
*  for each item with identical NSN and different PN,
*  present
*  in two or more aircraft.
*
CLEAR
USE D:\DIRMA\DIRMA1 INDEX D:\THPROG\NSNPNREQ
  SET FILTER TO LEN(TRIM(NSN))=13
  GO TOP
STORE 0 TO COUNT4
STORE 0 TO COUNT5
@ 8,10 SAY  " NUMBER OF REGISTERS CORRESPONDING TO"
@ 9,10 SAY  " ITEMS WITH IDENTICAL NSN AND DIFFERENT PN"
@ 10,10 SAY " PRESENT IN MORE THAN 1 TYPE OF AIRCRAFT"
@ 11,10 SAY " THAT WOULD REMAIN IN THE SYSTEM FOR"
@ 12,10 SAY " REFERENCE ONLY"
@ 15,10 SAY " NUMBER OF REQUISITIONS FOR ITEMS WITH"
@ 16,10 SAY " IDENTICAL NSN AND DIFFERENT PN THAT"
@ 17,10 SAY " WOULD NOT BE ACTIVE IN THE SYSTEM IF"
@ 18,10 SAY " COMMON ITEMS WERE BEING CENTRALLY MANAGED"
DO WHILE .NOT. EOF()
   STORE NSN TO NSN1
   STORE PN TO PN1
   STORE Q_REQ TO Q_REQ1
```

```
    SKIP 1
    IF .NOT. EOF()
       STORE NSN TO NSN2
       STORE PN TO PN2
       STORE Q_REQ TO Q_REQ2
    ENDIF
    IF NSN1=NSN2 .AND. PN1<>PN2
       STORE COUNT4+1 TO COUNT4
       @ 13,10 SAY COUNT4
       IF Q_REQ1='1' .AND. Q_REQ2='1'
          STORE COUNT5+1 TO COUNT5
          @ 19,10 SAY COUNT5
       ENDIF
    ENDIF
ENDDO
USE
* REPORT PROGRAM
* Description:  OUTPUT INVESTIGATIVE QUESTION A, PART B
* APPENDIX E
* VARIABLES
* ENVIRONMENT
  CLEAR
  set decimals to 10
  set deleted on
  set exact off
  set heading off
  set margin to 1
  set safety off
  set scoreboard off
  set device to print
* Go print/display the report
@ 5,10   SAY "Appendix F: Analysis Results for Items With
the Same"
@ 6,10   SAY "                NSN and different PN"
@ 11,10  SAY "Total quantity of items with the same NSN and"
@ 12,10  SAY "different PN present in more than one type of
aircraft:"
@ 13,10  "("
@ 13,11  SAY m->count3 picture '999999'
@ 13,17  SAY ")"
@ 17,10  SAY "Total quantity of registers corresponding to"
@ 18,10  SAY "items with the same NSN and different PN,"
@ 19,10  SAY "present in more than 1 type of aircraft, that"
@ 20,10  SAY "would remain in the system for reference
only:"
@ 21,10  SAY "("
@ 21,11  SAY m->count4 picture '999999'
@ 21,17  SAY ")"
@ 25,10  SAY "Total quantity of requisitions for items with
the same"
@ 26,10  SAY "NSN and different PN that would not exist in
the system"
```

```
@ 27,10  SAY "if common items were being centrally managed:"

@ 28,10  SAY "("
@ 28,11  SAY m->count5 picture '999999'
@ 28,17  SAY ")"
eject
set device to screen
SET EXACT ON
SET SCOREBOARD ON
* EOF B1.PRG
```

Appendix F: Analysis of Results for Items With the Same NSN and Different PN

Total quantity of specific NSNs duplicated in one or more projects (aircraft), with different PNs assigned in each of them:

511

Total quantity of registers corresponding to specific NSN duplicated in one or more projects, with different PN assigned in each project, that would remain in the system for reference only if common items were centrally managed:

532

Total quantity of different requisitions for each specific NSN duplicated in one or more aircraft, with different PN assigned in each project, that were being processed in the supply system when the data-file was withdrawn, and would not exist in the system if common items were centrally managed:

2

Appendix G: DBASE III Program Employed to Analyze the Items With the Same PN, the Same CAGE, and Different NSN

```
* Application:  THESIS
* Description:  INVESTIGATIVE QUESTION A, PART C
* Author:       Maj BOARETO / Maj NELSON
* Program "C.PRG"
* Program objectives:
* 1. Place an identical code (3) in the data base field
*    "codel" for all items with identical PN, the same MFR
*     code (CAGE), and different NSN, present in two or
*     more aircraft;
* 2. Print a list of the items satisfying the conditions
*    specified in "1" above;
* 3. Count the number of items with the same PN, the same
*    CAGE, and different NSN present in two or more
*    aircraft, and print the total quantity;
* 4. Count the number of registers corresponding to items
*    with identical PN, the same CAGE, and different NSN,
*    present in more than one aircraft that could be
*    cancelled, depending on further analysis; and
* 5. Count the number of requisitions for items with
*    identical PN, the same CAGE, and different NSN present
*    in the system when the data base file was generated,
*    that would not exist if common items were centrally
*    managed, and print the total quantity.
*
CLEAR
SET TALK OFF
SET EXACT ON
USE D:\DIRMA\DIRMA1 INDEX D:\THPROG\PNMFRNSN
GO TOP
@ 10,10 SAY "INITIALIZING FIELD CODE1"
REPLACE CODE1 WITH 0 FOR CODE1<>0
@ 12,10 SAY "FIELD CODE1 SET TO ZERO"
GO TOP
STORE 0 TO COUNT6
@ 14,10 SAY "TOTAL QUANTITY OF ITEMS WITH IDENTICAL"
@ 15,10 SAY "PN, THE SAME CAGE, AND DIFFERENT NSN"
@ 16,10 SAY "PRESENT IN TWO OR MORE TYPES OF AIRCRAFT:"
DO WHILE .NOT. EOF()
 STORE PN TO PN1
 STORE MFR TO MFR1
 STORE NSN TO NSN1
 SKIP 1
 IF .NOT. EOF()
    STORE PN TO PN2
    STORE MFR TO MFR2
    STORE NSN TO NSN2
```

```
 ENDIF
 IF .NOT. EOF()
    STORE PN TO PN3
    STORE MFR TO MFR3
    STORE NSN TO NSN3
 ENDIF
 IF PN1=PN2 .AND. MFR1=MFR2 .AND. NSN1<>NSN2
      SKIP -2
      COUNT6=COUNT6+1
      REPLACE CODE1 WITH 3
      SKIP 1
      REPLACE CODE1 WITH 3
      @ 17,10 SAY COUNT6
        SKIP 1
    DO WHILE PN3=PN2 .AND. MFR3=MFR2 .AND. NSN3<>NSN2 .AND.
.NOT. EOF()
       IF .NOT. EOF()
        REPLACE CODE1 WITH 3
        SKIP 1
       ENDIF
       IF .NOT. EOF()
          STORE PN TO PN3
          STORE MFR TO MFR3
          STORE NSN TO NSN3
       ENDIF
    ENDDO
 ENDIF
   IF PN1<>PN2 .OR. MFR1<>MFR2 .OR. NSN1=NSN2
     IF .NOT. EOF()
       SKIP -1
     ENDIF
   ENDIF
ENDDO
*
CLEAR
USE D:\DIRMA\DIRMA1 INDEX D:\THPROG\PMNREQ
GO TOP
STORE 0 TO COUNT7
STORE 0 TO COUNT8
@ 8,10  SAY "NUMBER OF REGISTERS CORRESPONDING TO ITEMS
WITH"
@ 9,10  SAY "IDENTICAL PN, THE SAME CAGE, AND DIFFERENT
NSN,"
@ 10,10 SAY "PRESENT IN MORE THAN 1 TYPE OF AIRCRAFT, THAT"
@ 11,10 SAY "COULD BE CANCELLED FROM THE SYSTEM DEPENDING"
@ 12,10 SAY "ON FURTHER ANALYSIS"
@ 15,10 SAY "NUMBER OF REQUISITIONS FOR ITEMS WITH
IDENTICAL"
@ 16,10 SAY "PN, THE SAME CAGE, AND DIFFERENT NSN THAT
WOULD"
@ 17,10 SAY "NOT BE ACTIVE IN THE SYSTEM IF COMMON ITEMS
WERE"
@ 18,10 SAY "BEING CENTRALLY MANAGED"
```

```
DO WHILE .NOT. EOF()
   STORE PN TO PN1
   STORE MFR TO MFR1
   STORE NSN TO NSN1
   STORE Q_REQ TO Q_REQ1
   SKIP 1
   IF .NOT. EOF()
      STORE PN TO PN2
      STORE MFR TO MFR2
      STORE NSN TO NSN2
      STORE Q_REQ TO Q_REQ2
   ENDIF
   IF PN1=PN2 .AND. MFR1=MFR2 .AND. NSN1<>NSN2
      STORE COUNT7+1 TO COUNT7
      @ 13,10 SAY COUNT7
      IF Q_REQ1='1' .AND. Q_REQ2='1'
         STORE COUNT8+1 TO COUNT8
         @ 19,10 SAY COUNT8
      ENDIF
   ENDIF
ENDDO
* REPORT PROGRAM
* Description:  OUTPUT INVESTIGATIVE QUESTION A, PART C
* VARIABLES
* ENVIRONMENT
  CLEAR
set decimals to 10
  set deleted on
  set exact off
  set heading off
  set margin to 1
  set safety off
  set scoreboard off
  set device to print
* Go print/display the report
@ 5,10  SAY "Appendix H: Analysis Results for Items With the
Same"
@ 6,10  SAY "          PN and CAGE, but different NSN"
@ 10,10  say "Total quantity of items with the same PN and
CAGE, but"
@ 11,10 say "different NSN used in more than one type of
aircraft:"
@ 12,10 say "("
@ 12,11 say m->count6 picture '999999'
@ 12,17 say ")"
@ 16,10 say "Total quantity of registers corresponding to
items"
@ 17,10 say "with the same PN and CAGE, but different NSN,"
@ 18,10 say "present in more than 1 type of aircraft, that
could"
@ 19,10 say "be cancelled, depending on further analysis:"
@ 20,10 say "("
@ 20,11 say m->count7 picture '999999'
```

```
@ 20,17 say ")"
@ 24,10 say "Total quantity of requisitions for items with
the same"
@ 25,10 say "PN and CAGE, but different NSN that would not
exits in"
@ 26,10 say "the system if common items were being centrally
managed:"
@ 27,10 say "("
@ 27,11 say m->count8 picture '999999'
@ 27,17 say ")"
eject
set device to screen
SET EXACT ON
SET SCOREBOARD ON
* EOF OUTPUT1.PRG
```

Appendix H: Analysis of Results for Items With the Same PN and CAGE, but Different NSN

Total quantity of items with the same PN and CAGE, but different NSN, duplicated in one or more type of aircraft:
4156

Total quantity of registers corresponding to items with specific PN and CAGE, but different NSN, present in more than one type of aircraft (project), that could be canceled, depending on further analysis:
4955

Total quantity of different requisitions for each individual item with specific PN and CAGE duplicated in one or more projects, having different NSN in each project, that were being processed in the supply system when the data-file was withdrawn, and would not exist in the system if common items were centrally managed:
22

Appendix I: Program in QUATTRO PRO Used in the Analysis of Investigative Question b

```
                       +-----------------+
                       |   FIRST SCREEN  |
                       +-----------------+

S1        {GOTO}EMPTY~{PANELOFF}{CONTENTS AC16,AN4}
          /gndFIG1~q
          /gndFIG2~q
          {IF AN3=0}{LET AC14,BO3,STRING}
          {GOTO}Z1~
          {SETUP0}{SETUP1}/xmmain~

\t        {goto}empty~/xmmain~

                                 +-----------------+
                                 |INITIAL SETTINGS |
                                 +-----------------+
SETUP1    {GOTO}EMPTY~
          /OFHYQQ
          {/ Query;Block}A37.S202~    Criteria Table
          {/ Query;CriteriaBlock}
          AU19.AU20~                      CONSUMP
          {/ Query;Output}CF7.CS7~       +CONSUMP>0
          /DQEQ
          {/ Query;Block}A213.S323~   Criteria Table
          {/ Query;CriteriaBlock}
          AU24.AU25~                      CONSUMP
          {/ Query;Output}DC7.DP7~      +CONSUMP1>0
          /DQEQ
          /PLBNQQ
          {RETURN}

SETUP0    {GOTO}EMPTY~
          {/ Query;Block}A38.S202~
          /DSBA38.S188~
          1A38~A~
          2D38~A~G
          {/ Query;Block}A214.S323~
          /DSBA214.S323~
          1A214~A~
          2D214~A~G
          {RETURN}

PRESENT   {GOTO}EMPTY~
          {GOTO}D16~{IF AND16=0}~
          {LET AC14,BO3,STRING}~
          {CONTENTS AC17,AN4}~
          {RETURN}~
```

```
SETUP2    {GOTO}FLEET~/SSNAD47.AD55~
          {IF CHOICE="Y"}{MSGFLEET}
          /SSGAD47.AD55~
          /xmmfleet~

OPTION1   {GOTO}QPLNEW~
          /SSNAD47.AD55~/SSGAD48.AE48~
          {GOTO}QPLNEW~/XNQuantity of aircraft?~~
          {MENUCALL MCONFIRM}
          {IF CONFIRM="Y"}{BRANCH C1C}
          /SSNAD48.AE48~
          {LET QPLNEW,0}{GOTO}FLEET~
          /xmmfleet~

C1C       /SSGAD48.AE48~
          {LET QPL,QPLNEW}{LET QPLNEW,0}
          {GOTO}FLEET~/SSNAD48.AE48~
          /xmmfleet~

OPTION2   {GOTO}HPLNEW~
          /SSNAD47.AD55~/SSGAD51.AE51~
          {GOTO}HPLNEW~/XNNumber of hours per
aircraft per year?
          {MENUCALL MCONFIRM}
          {IF CONFIRM="Y"}{BRANCH C2C}
          /SSNAD51.AE51~
          {LET HPLNEW,0}{GOTO}FLEET~
          /xmmfleet~

C2C       /SSGAD51.AE51~
          {LET HPL,HPLNEW}{LET HPLNEW,0}
          {GOTO}FLEET~/SSNAD51.AE51~
          /xmmfleet~

OPTION3   {GOTO}EFFORTN~
          /SSNAD47.AD55~/SSGAD54.AE54~
          {GOTO}EFFORTN~/XNFleet's annual effort?~~
          {MENUCALL MCONFIRM}
          {IF CONFIRM="Y"}{BRANCH C3C}
          /SSNAD54.AE54~
          {LET EFFORTN,0}{GOTO}FLEET~
          /xmmfleet~

C3C       /SSGAD54.AE54~
          {LET EFFORT,EFFORTN}{LET EFFORTN,0}
          {GOTO}FLEET~/SSNAD54.AE54~
          /xmmfleet~

SETUP3    {GOTO}ENG~/SSNAD79.AD86~
          {IF CHOICE="Y"}{MSGREP}
          /SSGAD79.AD86~
          /xmmrepl~
```

```
          OPT3/1    {GOTO}MAC1NEW~
                    /SSNAD79.AD86~/SSGAD79.AE79~
                    {GOTO}MAC1NEW~/XNMonthly average
consumption?~~
                    {MENUCALL MCONFIRM}
                    {IF CONFIRM="Y"}{BRANCH S31C}
                    /SSNAD79.AE79~
                    {LET MAC1NEW,0}{GOTO}ENG~
                    /xmmrepl~

          S31C      {GOTO}MAC1~/SSGAD79.AE79~
                    {LET MAC1,MAC1NEW}{LET MAC1NEW,0}
                    {GOTO}ENG~/SSNAD79.AE79~
                    /xmmrepl~

          OPT3/2    {GOTO}STK1NEW~
                    /SSNAD79.AD86~/SSGAD82.AE82~
                    {GOTO}STK1NEW~/XN  Current stock?~~
                    {IF STK1NEW>SPR1}{BRANCH ERR1}
                    {MENUCALL MCONFIRM}
                    {IF CONFIRM="Y"}{BRANCH S32C}
                    /SSNAD82.AE82~
                    {LET STK1NEW,0}
                    {IF CONFIRM="M"}{LET CONFIRM,"N"}/xmmain~
                    {GOTO}ENG~/xmmrepl~

          ERR1      {MSGSTK}{LET STK1NEW,0}
                    {GOTO}ENG~/SSNAD82.AE82~
                    /xmmrepl~

          S32C      /SSGAD82.AE82~
                    {LET STK1,STK1NEW}{LET STK1NEW,0}
                    {GOTO}ENG~/SSNAD82.AE82~
                    /xmmrepl~

          OPT3/3    {GOTO}SPR1NEW~
                    /SSNAD79.AD86~/SSGAD84.AE84~
                    {GOTO}SPR1NEW~/XNHow many spare engines
currently exis
                    {MENUCALL MCONFIRM}
                    {IF CONFIRM="Y"}{BRANCH S33C}
                    /SSNAD84.AE84~
                    {LET SPR1NEW,0}
                    {IF CONFIRM="M"}{LET CONFIRM,"N"}/xmmain~
                    {GOTO}ENG~/xmmrepl~

          S33C      /SSGAD84.AE84~
                    {LET SPR1,SPR1NEW}{LET SPR1NEW,0}
                    {GOTO}ENG~/SSNAD84.AE84~
                    /xmmrepl~


          OPT3/4    {GOTO}MTBF1N~
```

```
                      /SSNAD79.AD86~/SSGAD86.AE86~
                      {GOTO}MTBF1N~/XNWhat is the new MTBF for
the engine?~~
                      {MENUCALL MCONFIRM}
                      {IF CONFIRM="Y"}{BRANCH S34C}
                      /SSNAD86.AE86~
                      {LET MTBF1N,0}
                      {IF CONFIRM="M"}{LET CONFIRM,"N"}/xmmain~
                      {GOTO}ENG~/xmmrep1~

          S34C        /SSGAD86.AE86~
                      {LET MTBF1,MTBF1N}{LET MTBF1N,0}
                      {GOTO}ENG~/SSNAD86.AE86~
                      /xmmrep1~

          SETUP4      {GOTO}PROP~/SSNAD112.AE120~
                      {IF CHOICE="Y"}{MSGREP}
                      /SSGAD112.AD120~
                      /xmmrep2~

          OPT4/1      {GOTO}MAC2NEW~
                      /SSNAD112.AD120~/SSGAD112.AE112~
                      {GOTO}MAC2NEW~/XNMonthly average
consumption?~~
                      {MENUCALL MCONFIRM}
                      {IF CONFIRM="Y"}{BRANCH S41C}
                      /SSNAD112.AE112~
                      {LET MAC2NEW,0}
                      {IF CONFIRM="M"}{LET CONFIRM,"N"}/xmmain~
                      {GOTO}PROP~/xmmrep2~

          S41C        /SSGAD112.AE112~
                      {LET MAC2,MAC2NEW}{LET MAC2NEW,0}
                      {GOTO}PROP~/SSNAD112.AE112~
                      /xmmrep2~

          OPT4/2      {GOTO}STK2NEW~
                      /SSNAD112.AD120~/SSGAD115.AE115~
                      {GOTO}STK2NEW~/XN  Current stock?~~
                      {IF STK2NEW>SPR2}{BRANCH ERR2}
                      {MENUCALL MCONFIRM}
                      {IF CONFIRM="Y"}{BRANCH S42C}
                      /SSNAD115.AE115~
                      {LET STK2NEW,0}
                      {IF CONFIRM="M"}{LET CONFIRM,"N"}/xmmain~
                      {GOTO}PROP~/xmmrep2~

          ERR2        {MSGSTK}{LET STK2NEW,0}
                      {GOTO}PROP~/SSNAD115.AE115~
                      /xmmrep2~
```

```
          S42C      /SSGAD115.AE115~
                    {LET STK2,STK2NEW}{LET STK2NEW,0}
                    {GOTO}PROP~/SSNAD115.AE115~
                    /xmmrep2~

          OPT4/3    {GOTO}SPR2NEW~
                    /SSNAD112.AD120~/SSGAD117.AE117~
                    {GOTO}SPR2NEW~/XNHow many spare
propellers currently exist?~~
                    {MENUCALL MCONFIRM}
                    {IF CONFIRM="Y"}{BRANCH S43C}
                    /SSNAD117.AE117~
                    {LET SPR2NEW,0}

          S43C      /SSGAD117.AE117~
                    {LET SPR2,SPR2NEW}{LET SPR2NEW,0}
                    {GOTO}PROP~/SSNAD117.AE117~
                    /xmmrep2~

          OPT4/4    {GOTO}MTBF2N~
                    /SSNAD112.AD120~/SSGAD120.AE120~
                    {GOTO}MTBF2N~/XNWhat is the new MTBF for
the propeller?~~
                    {MENUCALL MCONFIRM}
                    {IF CONFIRM="Y"}{BRANCH S44C}
                    /SSNAD120.AE120~
                    {LET MTBF2N,0}
                    {IF CONFIRM="M"}{LET CONFIRM,"N"}/xmmain~
                    {GOTO}PROP~/xmmrep2~

          S44C      /SSGAD120.AE120~
                    {LET MTBF2,MTBF2N}{LET MTBF2N,0}
                    {GOTO}PROP~/SSNAD120.AE120~
                    /xmmrep1~

                                                   +-----------------+
                                                   |EXIT WITHOUT SAVE|
                                                   +-----------------+

          EXIT     {MESSAGE BO9.BR11,10,5,+@NOW+@TIME(0,0,6)}
                   /xmmenuleav~

MENULEAV Do not exSave and Exit
         Return toSave thisExit program without saving job
already done
                    {GOTO}EMP{BRANCH S{GOTO}EMPTY~
                                                  /FXY~

                                                   +-----------------+
                                                   |  SAVE AND EXIT  |
                                                   +-----------------+
          SAVEXIT   {LET SAVEOUT,"Y"}~
                    {BRANCH SAVSTAY}
```

```
                 +------------------------------------+
                 ¦  SAVE AND REMAIN IN THE PROGRAM    ¦
                 +------------------------------------+
SAVSTAY   {GOTO}SAVPLACE~
          {IF CHOICE="Y"}{MSGFILE}
          {GOTO}FILENEW~/XLName of the file? (max 8
characters)~
          {IF FILENEW=FILEOLD1}{BRANCH SAMENAME}
          {CONTENTS PLACE1,FILENEW}
          {CONTENTS FILEOLD1,FILENEW}
          {CONTENTS FILEOLD,FILENEW}
          {MSGSAV}{LET FILENEW," "}
          {GOTO}EMPTY~
          {/ File;Save}{CLEAR}
          A:FINAL1
          ~{CONTENTS UPDATE,TODAY}
          {IF SAVEOUT="Y"}{LET SAVEOUT,"N"}/FXY~
          {GOTO}EMPTY~/xmmain~

SAMENAME  {CONTENTS FILENEW,FILEOLD1}
          {CONTENTS PLACE2,FILENEW}
          {CONTENTS FILEOLD,FILENEW}
          {MSGSAV}{LET FILENEW," "}
          {GOTO}EMPTY~
          {/ File;Save}{CLEAR}
          A:FINAL
          ~R{CONTENTS UPDATE,TODAY}
          {IF SAVEOUT="Y"}{LET SAVEOUT,"N"}/FXY~
          {GOTO}EMPTY~'/xmmain~

                       +------------------+
                       ¦ PRINTED OUTPUTS  ¦
                       +------------------+

                       +----------------------------+
                       ¦    Comparing Forecasts     ¦
                       +----------------------------+

                                +---------+
                                ¦ Proplr  ¦
                                +---------+

PRINT1    {LET PAGEOUT,1}{GOTO}EMPTY~{MSGPRINT}
          {CONTENTS DATEOUT,TODAY}
          {LET NEEDED,PROPDEMD}~
          {LET NAMEOUT,"Propeller"}
          {LET PNOUT,"54H60-117"}
          /ECS10.Y11~EY5.FE6~
          /SLEY4.FE4~BDQ
          /EVDC8.DC46~EY7.EY45~
          /EVDT8.DT46~FA7.FA45~
          /EVDU8.DU46~FB7.FB45~
```

```
          /EVDV8.DV46~FC7.FC45~
          /EVDW8.DW46~FD7.FD45~
          /EVDX8.DX46~FE7.FE45~
          /PBEY1.FE46~AAASASASDPSQ
          {IF DC47<>""}{BRANCH PAGE2}
          /PAFQ
          /EEEY5.FE46~
          /xmmoutput~

PAGE2     {LET PAGEOUT,2}{MSGPRINT}
          {CONTENTS DATEOUT,TODAY}
          /ECS10.Y11~EY84.FE85~
          /SLEY83.FE83~BDQ
          /EVDC47.DC84~EY87.EY124~
          /EVDT47.DT84~FA87.FA124~
          /EVDU47.DU84~FB87.FB124~
          /EVDV47.DV84~FC87.FC124~
          /EVDW47.DW84~FD87.FD124~
          /EVDX47.DX84~FE87.FE124~
          {MSGPRT}
          /PAFASASASQ
          /PBEY80.FE124~DPSAFQ
          /EEEY86.FE131~
          /xmmoutput~

                              +--------+
                              | Engine |
                              +--------+
PRINT2    {LET PAGEOUT,1}{MSGPRINT}
          {CONTENTS DATEOUT,TODAY}
          {LET NEEDED,ENGDEMD}~
          {LET NAMEOUT,"Engine"}
          {LET PNOUT,"T56A15"}
          /ECS10.Y11~EY5.FE6~
          /SLEY4.FE4~BDQ
          /EVCF8.CF46~EY7.EY45~
          /EVCV8.CV46~FA7.FA45~
          /EVCW8.CW46~FB7.FB45~
          /EVCX8.CX46~FC7.FC45~
          /EVCY8.CY46~FD7.FD45~
          /EVCZ8.CZ46~FE7.FE45~
          /PBEY1.FE46~AAASASASDPSQ
          {IF CF47<>""}{BRANCH PAGE22}
          /PAFQ
          /EEEY5.FE46~
          /xmmoutput~

PAGE22    {LET PAGEOUT,2}{MSGPRINT}
          {CONTENTS DATEOUT,TODAY}
          /ECS10.Y11~EY84.FE85~
          /SLEY83.FE83~BDQ
          /EVCF47.CF84~EY87.EY124~
```

```
          /EVCV47.CV84~FA87.FA124~
          /EVCW47.CW84~FB87.FB124~
          /EVCX47.CX84~FC87.FC124~
          /EVCY47.CY84~FD87.FD124~
          /EVCZ47.CZ84~FE87.FE124~
          /PAFASASASQ
          /PBEY80.FE124~DPSAFQ
          /EEEY86.FE131~
          /xmmoutput~

               +---------+
               ¦ Engine  ¦
               +---------+
PRINT3    {GOTO}EMPTY~
          /SLCE7.CT77~BSQ
          /PDGLOBQBCE1.CT64~PQ{MSGPRINT}
          /SLCE7.CT7~BNQ
          /xmmoutput~

               +---------+
               ¦ Proplr  ¦
               +---------+
PRINT4    {GOTO}EMPTY~
          /SLDB7.DP7~BSQ
          /PDGLOBQBDB1.DP64~PQ
          /SLDB7.DP7~BNQ
          /xmmoutput~
                   +--------+
                   ¦ Engine ¦
                   +--------+

PRINT5    {LET PAGEOUT,1}{MSGPRINT}
          {CONTENTS DATEOUT,TODAY}
          {LET NEEDED,ENGDEMD}~
          /EEEA5.EG100~
          {LET NAMEOUT,"Engine"}/PDPQ
          {LET PNOUT,"T56A15"}{LET REP,"Report 2"}
          /ECS14.Y15~EA5.EG6~
          /SLEA6.EG6~BDQ
          /EVCF8.CF46~EA7.EA45~    PN
          /EVCH8.CH46~EC7.EC45~    NSN
          /EVCJ8.CJ46~EE7.EE45~    NAME
          /EVCL8.CL46~EG7.EG45~    STOCK UNIT
          /PBEA1.EG45~AAASASASDPSQ
          /EEEA5.EG46~
          {IF CF47<>""}{BRANCH PAGE52}
          /PAFQ
          {BRANCH PRINT6}

PAGE52    {LET PAGEOUT,2}{MSGPRINT}
          {CONTENTS DATEOUT,TODAY}
          {LET NAMEOUT,"Engine"}
          {LET PNOUT,"T56A15"}{LET REP,"Report 2"}
```

```
          /ECS14.Y15~EA5.EG6~
          /SLEA6.EG6~BDQ
          /EVCF47.CF84~EA7.EA45~       PN
          /EVCH47.CH84~EC7.EC45~       NSN
          /EVCJ47.CJ84~EE7.EE45~       NAME
          /EVCL47.CL84~EG7.EG45~       STOCK UNIT
          /PAFASASASQ
          /PBEA1.EG45~DPSAFQ
          {IF CF85<>""}{MSGPAGE}
          /EEEA5.EG100~
          {BRANCH PRINT6}

PRINT6    {LET PAGEOUT,1}{MSGPRINT}
          {CONTENTS DATEOUT,TODAY}
          {LET NAMEOUT,"Engine"}
          {LET PNOUT,"T56A15"}{LET REP,"Report 3"}
          /ECS7.Y8~EA5.EG6~
          /SLEA6.EG6~BDQ
          /EVCF8.CF46~EA7.EA45~         PN
          /EVCS8.CS46~EC7.EC45~         QPA
          /EVCM8.CM46~ED7.ED45~         CONSUMPTION
          /EVCN8.CN46~EE7.EE45~         STOCK UNIT
          /EVCO8.CO46~EF7.EF45~         CREDIT
          /PBEA1.EG45~AAASASASDPSQ
          /EEEA5.EG100~
          {IF CF47<>""}{BRANCH PAGE62}
          /PAFQ
          {BRANCH PRINT7}

PAGE62    {LET PAGEOUT,2}{MSGPRINT}
          {CONTENTS DATEOUT,TODAY}
ut, or go{LET NAMEOUT,"Engine"}
          {LET PNOUT,"T56A15"}{LET REP,"Report 3"}
          /ECS7.Y8~EA5.EG6~
          /SLEA6.EG6~BDQ
          /EVCF47.CF84~EA7.EA45~         PN
          /EVCS47.CS84~EC7.EC45~         QPA
          /EVCM47.CM84~ED7.ED45~         CONSUMPTION
          /EVCN47.CN84~EE7.EE45~         STOCK UNIT
          /EVCO47.CO84~EF7.EF45~         CREDIT
          /PAFASASASQ
          /PBEA1.EG45~DPSAFQ
          {IF CF85<>""}{MSGPAGE}
          /EEEA5.EG100~
          {BRANCH PRINT7}

PRINT7    {LET PAGEOUT,1}{MSGPRINT}
          {CONTENTS DATEOUT,TODAY}
          {LET NAMEOUT,"Engine"}
          {LET PNOUT,"T56A15"}{LET REP,"Report 4"}
          /ECBG192.BM193~EA5.EG6~
          /SLEA6.EG6~BDQ
          /EVCF8.CF46~EA7.EA45~            PN
```

```
        /EVCS8.CS46~EC7.EC45~                QPA
        /EVCP8.CP46~ED7.ED45~            MEAN PRICE
        /EVCQ8.CQ46~EE7.EE45~          REORDER POINT
        /EVCR8.CR46~EF7.EF45~          MAX LEVEL
        /PBEA1.EG45~AAASASASDPSQ
        /EEEA5.EG100~
        {IF CF47<>""}{BRANCH PAGE72}
        /PAFQ
        {BRANCH PRINT7}

PAGE72  {LET PAGEOUT,2}{MSGPRINT}
        {CONTENTS DATEOUT,TODAY}
        {LET NAMEOUT,"Engine"}
        {LET PNOUT,"T56A15"}{LET REP,"Report 4"}
        /ECS7.Y8~EA5.EG6~
        /SLEA6.EG6~BDQ
        /EVCF47.CF84~EA7.EA45~               PN
        /EVCS47.CS84~EC7.EC45~               QPA
        /EVCP47.CP84~EE7.EE45~          MEAN PRICE
        /EVCQ47.CQ84~EG7.EG45~          REORDER POINT
        /EVCR47.CR84~EG7.EG45~          MAX LEVEL
        /PAFASASASQ
        /PBEA1.EG45~DPSAFQ
        {IF CF85<>""}{MSGPAGE}
        /EEEA5.EG100~
        /xmmoutput~

                    +--------+
                    |Propell |
                    +--------+

PRINT5P {LET PAGEOUT,1}{MSGPRINT}
        {CONTENTS DATEOUT,TODAY}
        {LET NEEDED,PROPDEMD}~
        /EEEA5.EG100~
        {LET NAMEOUT,"Propeller"}/PDPQ
        {LET PNOUT,"54H60-117"}
        {LET REP,"Report 2"}
        /ECS14.Y15~EA5.EG6~
        /SLEA6.EG6~BDQ
        /EVDC8.DC46~EA7.EA45~          PN
        /EVDE8.DE46~EC7.EC45~          NSN
        /EVDG8.DG46~EE7.EE45~          NAME
        /EVDI8.DI46~EG7.EG45~          STOCK UNIT
        /PBEA1.EG45~AAASASASDPSQ
        /EEEA5.EG100~
        {IF DC47<>""}{BRANCH PAGE52P}
        /PAFQ
        {BRANCH PRINT6P}

PAGE52P {LET PAGEOUT,2}{MSGPRINT}
        {CONTENTS DATEOUT,TODAY}
        {LET NAMEOUT,"Propeller"}
```

```
        {LET PNOUT,"54H60-117"}
        {LET REP,"Report 2"}
        /ECS14.Y15~EA5.EG6~
        /SLEA6.EG6~BDQ
        /EVDC47.DC84~EA7.EA45~          PN
        /EVDE47.DE84~EC7.EC45~          NSN
        /EVDG47.DG84~EE7.EE45~          NAME
        /EVDI47.DI84~EG7.EG45~          STOCK UNIT
        /PAFASASASQ
        /PBEA1.EG45~DPSAFQ
        {IF DC85<>""}{MSGPAGE}
        /EEEA5.EG100~
        {BRANCH PRINT6P}

PRINT6P {LET PAGEOUT,1}{MSGPRINT}
        {CONTENTS DATEOUT,TODAY}
        {LET NAMEOUT,"Propeller"}
        {LET PNOUT,"54H60-117"}
        {LET REP,"Report 3"}
        /ECS7.Y8~EA5.EG6~
        /SLEA6.EG6~BDQ
        /EVDC8.DC46~EA7.EA45            PN
        /EVDP8.DP46~EC7.EC45~           QPA
        /EVDJ8.DJ46~ED7.ED45~           CONSUMPTION
        /EVDK8.DK46~EE7.EE45~           TOTAL STOCK
        /EVDL8.DL46~EF7.EF45~           CREDIT
        /PBEA1.EG45~AAASASASDPSQ
        /EEEA5.EG100~
        {IF DC47<>""}{BRANCH PAGE62P}
        /PAFQ
        {BRANCH PRINT7P}

PAGE62P {LET PAGEOUT,2}{MSGPRINT}
        {CONTENTS DATEOUT,TODAY}
        {LET NAMEOUT,"Propeller"}
        {LET PNOUT,"54H60-117"}
        {LET REP,"Report 3"}
        /ECS7.Y8~EA5.EG6~
        /SLEA6.EG6~BDQ
        /EVDC47.DC84~EA7.EA45~          PN
        /EVDP47.DP84~EC7.EC45~          QPA
        /EVDJ47.DJ84~ED7.ED45~          CONSUMPTION
        /EVDK47.DK84~EE7.EE45~          STOCK UNIT
        /EVDL47.DL84~EF7.EF45~          CREDIT
        /PAFASASASQ
        /PBEA1.EG45~DPSAFQ
        {IF DC85<>""}{MSGPAGE}
        /EEEA5.EG100~
        {BRANCH PRINT7P}

PRINT7P {LET PAGEOUT,1}{MSGPRINT}
        {CONTENTS DATEOUT,TODAY}
        {LET NAMEOUT,"Propeller"}
```

```
         {LET PNOUT,"54H60-117"}
         {LET REP,"Report 4"}
         /ECBG192.BM193~EA5.EG6~
         /SLEA6.EG6~BDQ
         /EVDC8.DC46~EA7.EA45~          PN
         /EVDP8.DP46~EC7.EC45~          QPA
         /EVDM8.DM46~ED7.ED45~          MEAN PRICE
         /EVDN8.DN46~EE7.EE45~       REORDER POINT
         /EVDO8.DO46~EF7.EF45~       MAX LEVEL
         /PBEA1.EG45~AAASASASDPSQ
         /EEEA5.EG100~
         {IF DC47<>""}{BRANCH PAGE72P}
         /PAFQ
         /xmmoutput~

PAGE72P  {LET PAGEOUT,2}{MSGPRINT}
         {CONTENTS DATEOUT,TODAY}
         {LET NAMEOUT,"Propeller"}
         {LET PNOUT,"54H60-117"}
         {LET REP,"Report 4"}
         /ECS7.Y8~EA5.EG6~
         /SLEA6.EG6~BDQ
         /EVDC47.DC84~EA7.EA45~          PN
         /EVDP47.DP84~EC7.EC45~          QPA
         /EVDM47.DM84~EE7.EE45~          MEAN PRICE
         /EVDN47.DN84~EG7.EG45~       REORDER POINT
         /EVDO47.DO84~EG7.EG45~       MAX LEVEL
         /PAFASASASQ
         /PBEA1.EG45~DPSAFQ
         {IF DC85<>""}{MSGPAGE}
         /EEEA5.EG100~
         /xmmoutput~

                                   +------------------+
                                   ¦   SCREEN OUTPUT  ¦
                                   +------------------+
  TABLE  {IF OPTION="E"}{BRANCH SCREEN1E}
         {LET NEEDED,ENGDEMD}~
         {IF OPTION="P"}{BRANCH SCREEN1P}
         {LET NEEDED,PROPDEMD}~
         {LET OPTION,"P"}/xmmain~

  SPARE  {IF OPTION="E"}{BRANCH SCND}
         {LET NEEDED,ENGDEMD}~
         {IF DISPLAY=1}{BRANCH SCRN2AP}
         {LET NEEDED,PROPDEMD}~
         {BRANCH SCRN2BP}

  SCND   {IF DISPLAY=1}{BRANCH SCRN2AE}
         {BRANCH SCRN2BE}
```

```
                         +---------------------------+
                         |   PROGRAM FOR SCREEN 1    |
                         +---------------------------+
          SCREEN1P {GOTO}EMPTY~
                   /EEBV47.CC139~
                   {CONTENTS DATEOUT,TODAY}
                   {LET NAMEOUT,"Propeller"}{LET
NEEDED,PROPDEMD}~
                   {LET PNOUT,"54H60-117"}
                   /EVDC8.DC87~BV47.BV126~
                   /EVDT8.DT87~BX47.BX126~
                   /EVDU8.DU87~BY47.BY126~
                   /EVDV8.DV87~BZ47.BZ126~
                   /EVDW8.DW87~CA47.CA126~
                   /EVDX8.DX87~CB47.CB126~
                   {IF BV60<>""}/EMBV60.CC126~BV62~
                   {IF BV80<>""}/EMBV80.CC128~BV82~
                   {IF BV100<>""}/EMBV100.CC130~BV102~
                   {IF BV120<>""}/EMBV120.CC132~BV122~
                   {GOTO}BV42~{IF BV62<>""}/xmscrn1a~
                   /xmscrn1b~

          SCREEN1E {GOTO}EMPTY~
                   /EEBV47.CC150~
                   {CONTENTS DATEOUT,TODAY}
                   {LET NEEDED,ENGDEMD}~
                   {LET NAMEOUT,"Engine"}
                   {LET PNOUT,"T56A15"}
                   /EVCF8.CF87~BV47.BV126~
                   /EVCV8.CV87~BX47.BX126~
                   /EVCW8.CW87~BY47.BY126~
                   /EVCX8.CX87~BZ47.BZ126~
                   /EVCY8.CY87~CA47.CA126~
                   /EVCZ8.CZ87~CB47.CB126~
                   {IF BV60<>""}/EMBV60.CC126~BV62~
                   {IF BV80<>""}/EMBV80.CC128~BV82~
                   {IF BV100<>""}/EMBV100.CC130~BV102~
                   {IF BV120<>""}/EMBV120.CC132~BV122~
                   {GOTO}BV42~{IF BV62<>""}/xmscrn1a~
                   /xmscrn1b~

          SCN2     {GOTO}BV60~
                   {IF BV82<>""}/xmscrn2a~
                   /xmscrn2b~

          SCN3     {GOTO}BV80~
                   {IF BV102<>""}/xmscrn3a~
                   /xmscrn3b~

          SCN4     {GOTO}BV100~
                   {IF BV122<>""}/xmscrn4a~
                   /xmscrn4b~
```

```
SCN5      {GOTO}BV120~
          /xmscrn5~

SCN1UP    {GOTO}BV43~
          /xmscrn1a~

SCN2UP    {GOTO}BV60~
          /xmscrn2a~

SCN3UP    {GOTO}BV80~
          /xmscrn3a~

SCN4UP    {GOTO}BV100~
          /xmscrn4a~

                              +---------+
                              |SCREEN2  |
                              +---------+
SCRN2AP   {GOTO}EMPTY~
          /EEZ207.AG350~
          {CONTENTS DATEOUT,TODAY}
          {LET NAMEOUT,"Propeller"}
          {LET PNOUT,"54H60-117"}
          /ECAH43.AO43~Z207.AG207~
          /EVDC8.DC100~Z209.Z301~
          /EVDE8.DE100~AB209.AB301~           PN
          /EVDG8.DG100~AD209.AD301~           NSN
          /EVDI8.DI100~AF209.AF301~           NAME
          {IF Z222<>""}/EMZ222.AG301~Z224~   STOCK
          {IF Z242<>""}/EMZ242.AG303~Z244~
          {IF Z262<>""}/EMZ262.AG305~Z264~
          {IF Z282<>""}/EMZ282.AG307~Z284~
          {IF Z302<>""}/EMZ302.AG309~Z304~
          {GOTO}Z205~{IF Z224<>""}/xmscrn1c~
          /xmscrn1d~

SCRN2AE   {GOTO}EMPTY~
          /EEZ207.AG350~
          {CONTENTS DATEOUT,TODAY}
          {LET NAMEOUT,"Engine"}
          {LET PNOUT,"T56A15"}
          /ECAH43.AO43~Z207.AG207~
          /EVCF8.CF100~Z209.Z301~
          /EVCH8.CH100~AB209.AB301~     PN
          /EVCJ8.CJ100~AD209.AD301~      NSN
          /EVCL8.CL100~AF209.AF301~      NAME
          {IF Z222<>""}/EMZ222.AG301~Z224~ STOCK
          {IF Z242<>""}/EMZ242.AG303~Z244~
          {IF Z262<>""}/EMZ262.AG305~Z264~
          {IF Z282<>""}/EMZ282.AG307~Z284~
          {IF Z302<>""}/EMZ302.AG309~Z304~
          {GOTO}Z205~{IF Z224<>""}/xmscrn1c~
          /xmscrn1d~
```

```
SCRN2BE  {GOTO}EMPTY~
         /EEZ207.AG350~
         {CONTENTS DATEOUT,TODAY}
         {LET NAMEOUT,"Engine"}
         {LET PNOUT,"T56A15"}
         /ECAH47.AO48~Z207.AG208~
         /EVCF8.CF100~Z209.Z301~          PN
         /EVCS8.CS100~AB209.AB301~        QPA
         /EVCM8.CM100~AC209.AC301~        AVG CONS
         /EVCN8.CN100~AD209.AD301~        TOT STK
         /EVCO8.CO100~AE209.AE301~        CRED
         /EVCP8.CP100~AF209.AF301~        UNIT PRIC
         {IF Z222<>""}/EMZ222.AG301~Z224~
         {IF Z242<>""}/EMZ242.AG303~Z244~
         {IF Z262<>""}/EMZ262.AG305~Z264~
         {IF Z282<>""}/EMZ282.AG307~Z284~
         {IF Z302<>""}/EMZ302.AG309~Z304~
         {GOTO}Z205~{IF Z224<>""}/xmscrnlc~
         /xmscrnld~

SCRN2BP  {GOTO}EMPTY~
         /EEZ207.AG350~
         {CONTENTS DATEOUT,TODAY}
         {LET NAMEOUT,"Propeller"}
         {LET PNOUT,"54H60-117"}
         /ECAH47.AO48~Z207.AG208~
         /EVDC8.DC100~Z209.Z301~         PN
         /EVDP8.DP100~AB209.AB301        QPA
         /EVDJ8.DJ100~AC209.AC301~       AVG CONS
         /EVDK8.DK100~AD209.AD301~       TOT STK
         /EVDL8.DL100~AE209.AE301~       CRED
         /EVDM8.DM100~AF209.AF301~       UNIT PRIC
         {IF Z222<>""}/EMZ222.AG301~Z224~
         {IF Z242<>""}/EMZ242.AG303~Z244~
         {IF Z262<>""}/EMZ262.AG305~Z264~
         {IF Z282<>""}/EMZ282.AG307~Z284~
         {IF Z302<>""}/EMZ302.AG309~Z304~
         {GOTO}Z205~{IF Z224<>""}/xmscrnlc~
         /xmscrnld~

SCN2C    {GOTO}Z222~
         {IF Z244<>""}/xmscrn2c~
         /xmscrn2d~

SCN3C    {GOTO}Z242~
         {IF Z264<>""}/xmscrn3c~
         /xmscrn3d~

SCN4C    {GOTO}Z262~
         {IF Z284<>""}/xmscrn4c~
         /xmscrn4d~
```

```
SCN5C      {GOTO}Z304~
           /xmscrn5c~

SCN1UPC    {GOTO}Z205~
           /xmscrn1c~

SCN2UPC    {GOTO}Z222~
           /xmscrn2c~

SCN3UPC    {GOTO}Z242~
           /xmscrn3c~

SCN4UPC    {GOTO}Z262~
           /xmscrn4c~
```

Appendix J: Comparison of Forecasts for the Engines Shop, Fleet Effort 700 Hours per Aircraft per Year

```
-----------------------------------------------------------
Report 1  Name: Engine    PN: T56A15          Page        1
Fleet Effort: 700 Hours/Aircraft/year         Date 06/20/91
Engines Needed: 13                      List of Spare Parts
Project 300 Forecast Compared to Dependent Demand Forecast
-----------------------------------------------------------
```

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
115458	2	4	2	13	-9
180886	2	111	109	104	7
181398	2	193	191	182	11
181481	18	94	76	52	42
181829	4	37	33	13	24
181898	2	5	3	13	-8
187417	6	50	44	13	37
189153	2	4	2	13	-9
189156	4	12	8	13	-1
189328	4	70	66	26	44
189334	4	11	7	13	-2
189758	2	1	-1	13	-12
192462	4	266	262	13	253
2660351	16	10	-6	13	-3
557S16	4	8	4	13	-5
6739865	54	158	104	260	-102
6788286	4	41	37	26	15
6793461	2	20	18	13	7
6816058-2	10	6	-4	13	-7
6846212	8	54	46	13	41
6849497	4	28	24	13	15
6859086	28	38	10	52	-14
6870042	7	30	23	13	17
6878485	12	20	8	78	-58
7006603	4	49	45	117	-68
7006737	1	16	15	13	3
AM33K5E5823A	5	28	23	26	2
AMS1K7E5823A	22		-22	39	-39
AN960-8	60	765	705	91	674
AS3085-161	14		-14	13	-13
MS21083N4	41	57	16	52	5
MS3102R12S3P	2	59	57	13	46
MS9020-[illegible]	19	171	152	117	54
MS9089-18	2	198	196	13	185
RR106S	4	38	34	13	25

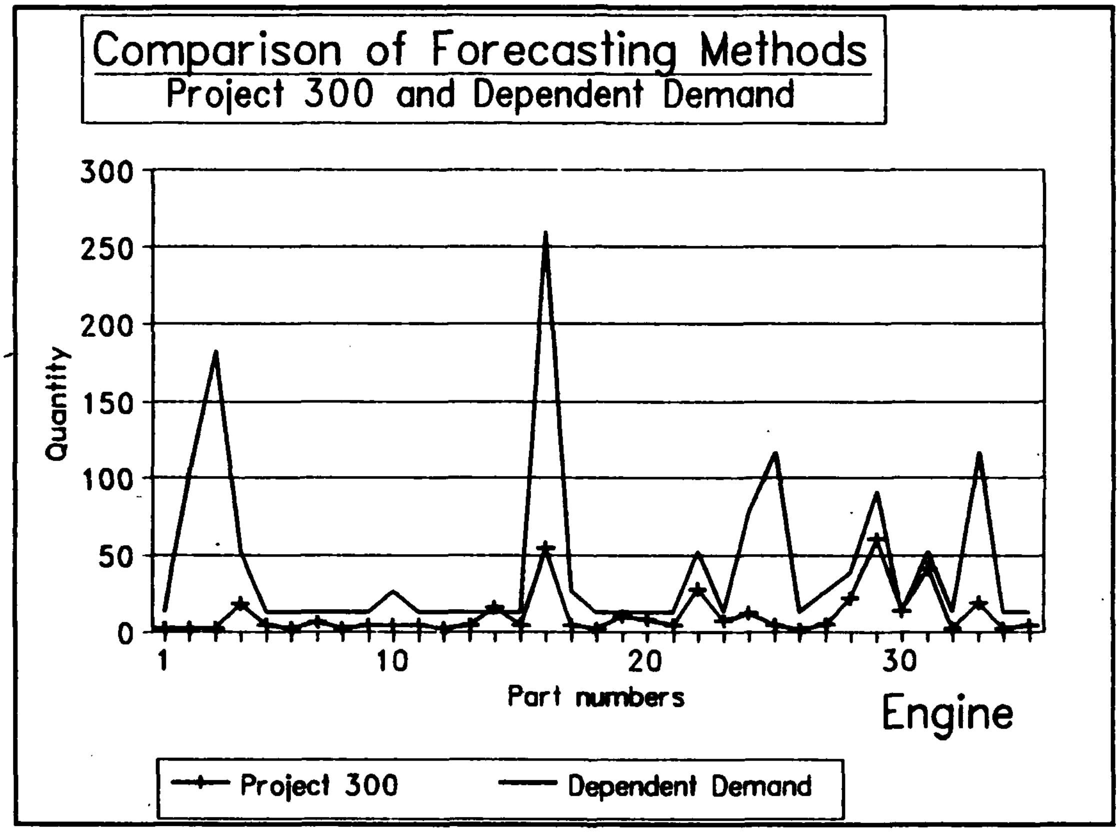

Figure 4. Comparison of Forecasting Methods (Engine). Annual Fleet Effort 700 Hours per Aircraft

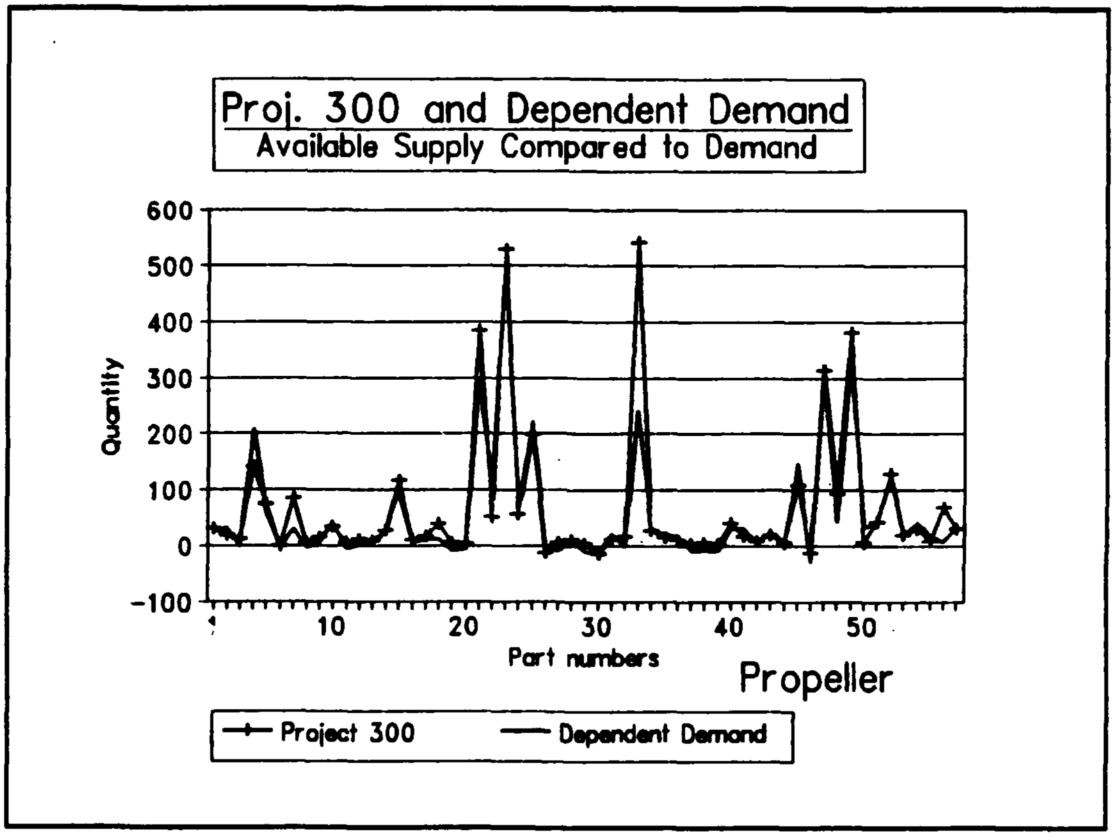

Figure 5. Available Supply Compared to Demand (Engine). Annual Fleet Effort 700 Hours per Aircraft

Appendix K: Comparison of Forecasts for the Propellers Shop, Fleet Effort 700 Hours per Aircraft per Year

Report 1 Name: Propeller PN: 54H60-117 Page 1
Fleet Effort: 700 Hours/Aircraft/year Date 06/20/91
Propellers Needed: 15 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand Forecast

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
01-10907	10	40	30	15	25
01-10939	28	46	18	15	31
296-19	16	28	12	30	-2
321319	127	268	141	60	208
322207-14S	2	76	74	15	61
507311-15	10	10		15	-5
509927	20	104	84	75	29
510230	6	10	4	15	-5
510231	4	19	15	15	4
510233	22	56	34	15	41
510234	5	9	4	15	-6
510239	4	16	12	15	1
511558	11	18	7	15	3
513681	13	39	26	15	24
513704	40	156	116	60	96
514287	10	20	10	15	5
514288	10	27	17	15	12
514796-1	4	42	38	30	12
514813	2	6	4	15	-9
514828-2	6	9	3	15	-6
520007	32	415	383	120	295
52479	73	124	51	15	109
525354	100	628	528	120	508
525644	34	90	56	15	75
527102	80	280	200	60	220
527124	25	12	-13	15	-3
536443	2	6	4	15	-9
536445	10	22	12	15	7
537297	2	4	2	15	-11
537819	14		-14	15	-15
539841	24	36	12	15	21
540346	11	27	16	30	-3
541017	150	690	540	450	240
541888	20	46	26	15	31
546385	20	34	14	15	19
546415	22	32	10	15	17
546569B	4	6	2	15	-9
547835	4	8	4	15	-7
547843	4	6	2	15	-9

Report 1 Name: Propeller PN: 54H60-117 Page 2
Fleet Effort: 700 Hours/Aircraft/year Date 06/20/91
Propellers Needed: 15 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand Forecast

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
548886	35	75	40	45	30
554861	43	60	17	30	30
557011	10	18	8	15	3
560768	20	40	20	15	25
560773	14	19	5	15	4
59723	83	191	108	45	146
69483G139-4359	13		-13	30	-30
69494R113	59	372	313	60	312
69494R117	10	102	92	60	42
69494R137	44	424	380	90	334
69494R250	43	48	5	15	33
69494R443	10	53	43	15	38
69494R9	7	136	129	15	121
69670-18-0	14	33	19	15	18
69917-062M375S	25	55	30	15	40
69923C4	40	47	7	30	17
69994P3-3C	28	96	68	90	6
726667-1	18	48	30	15	33
726681-1	20	46	26	15	31
737191-1	10	34	24	15	19
740313-3	10	9	-1	15	-6
7987IMA018	68	2	-66	15	-13
AN106512	46	108	62	75	33
AN106516	101	585	484	75	510
AN148662	96	105	9	60	45
AN148865	74	102	28	120	-18
AN315-8R	34	1262	1228	15	1247
AN381-4-20	138	980	842		980
AN960-416L	76	113	37	60	53
AN960-716	70	265	195	15	250
DCN4-4423	120	55	-65	30	25
M83248-2-117	96	161	65	60	101
MS16562-190	103	150	47	15	135
MS21044N4	13	97	84	75	22
MS24665-132	900	1154	254	75	1079
MS24665-281	22	771	749	15	756
MS24665-285	36	192	156	120	72
MS24665-88	618	895	277	45	850

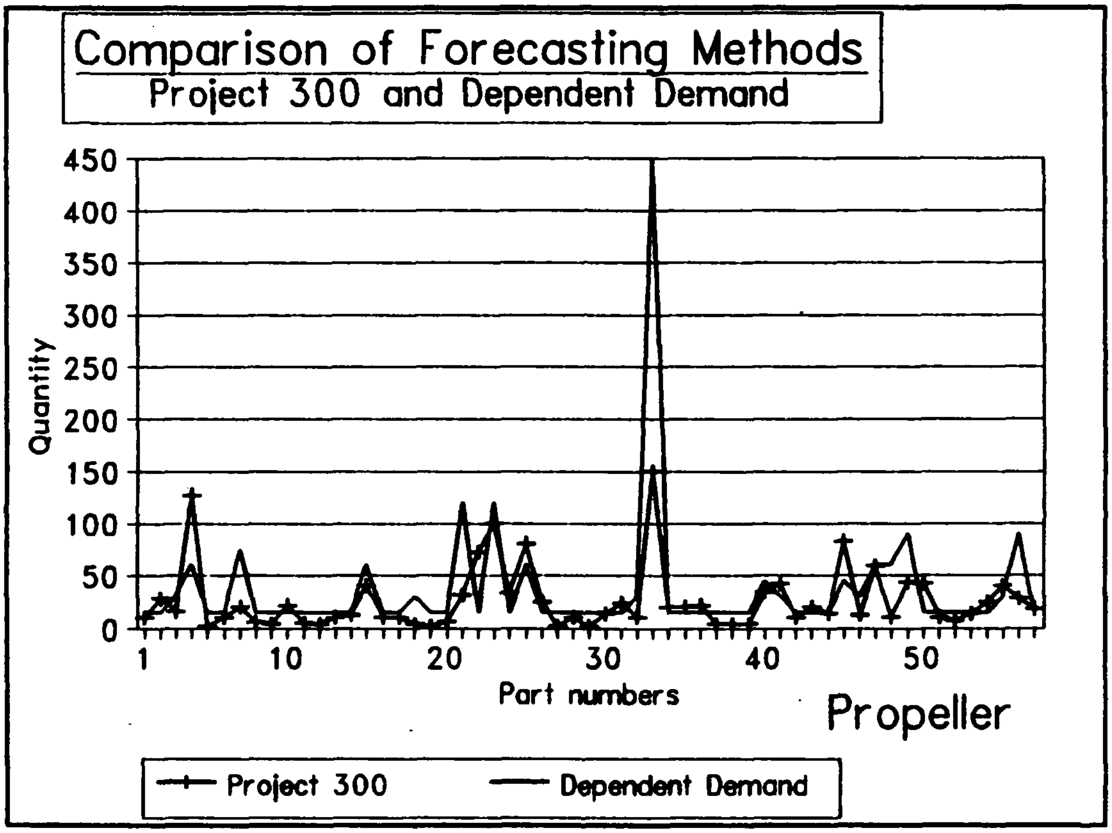

Figure 6. Comparison of Forecasting Methods (Propeller). Annual Fleet Effort 700 Hours per Aircraft

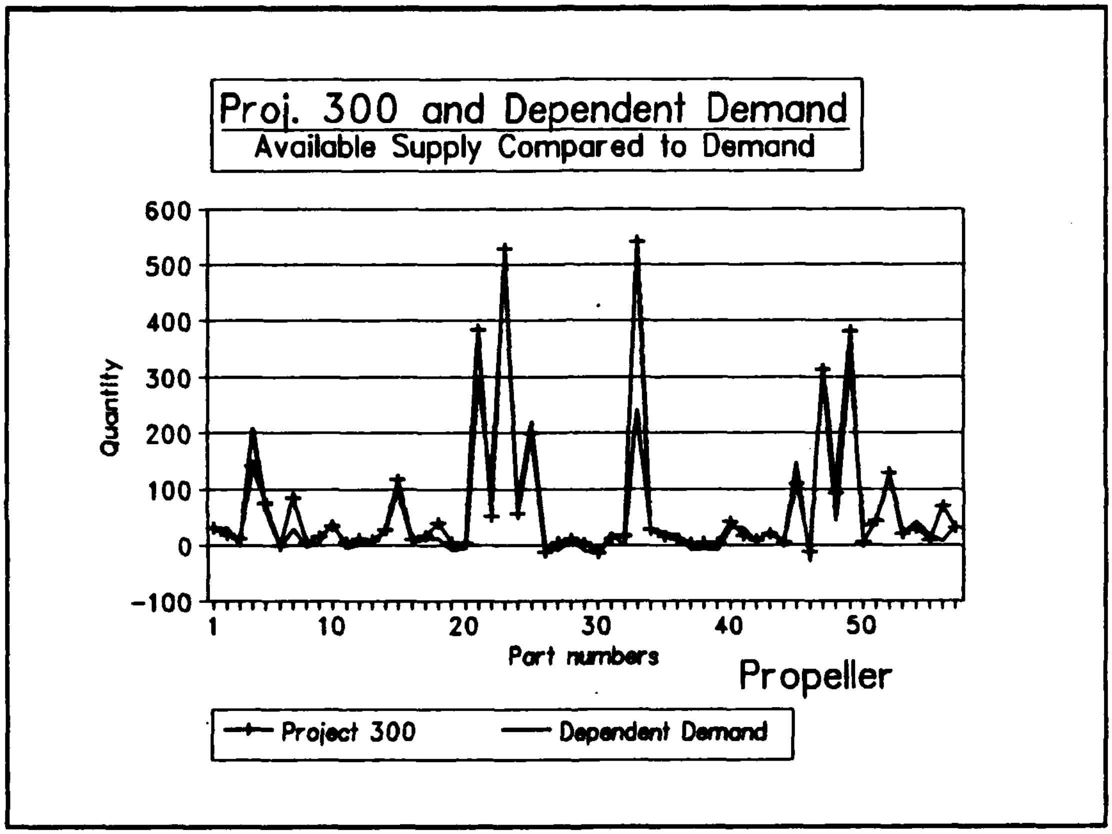

Figure 7. Available Supply Compared to Demand (Propeller). Annual Fleet Effort 700 Hours per Aircraft

Appendix L: Comparison of Forecasts for the Engines Shop, Fleet Effort 800 Hours per Aircraft per Year

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Report 1 Name: Engine PN: T56A15 Page 1
Fleet Effort: 800 Hours/Aircraft/year Date 06/20/91
Engines Needed: 15 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
115458	2	4	2	15	-11
180886	2	111	109	120	-9
181398	2	193	191	210	-17
181481	18	94	76	60	34
181829	4	37	33	15	22
181898	2	5	3	15	-10
187417	6	50	44	15	35
189153	2	4	2	15	-11
189156	4	12	8	15	-3
189328	4	70	66	30	40
189334	4	11	7	15	-4
189758	2	1	-1	15	-14
192462	4	266	262	15	251
2660351	16	10	-6	15	-5
557S16	4	8	4	15	-7
6739865	54	158	104	300	-142
6788286	4	41	37	30	11
6793461	2	20	18	15	5
6816058-2	10	6	-4	15	-9
6846212	8	54	46	15	39
6849497	4	28	24	15	13
6859086	28	38	10	60	-22
6870042	7	30	23	15	15
6878485	12	20	8	90	-70
7006603	4	49	45	135	-86
7006737	1	16	15	15	1
AM33K5E5823A	5	28	23	30	-2
AMS1K7E5823A	22		-22	45	-45
AN960-8	60	765	705	105	660
AS3085-161	14		-14	15	-15
MS21083N4	41	57	16	60	-3
MS3102R12S3P	2	59	57	15	44
MS9020-10	19	171	152	135	36
MS9089-18	2	198	196	15	183
RR106S	4	38	34	15	23

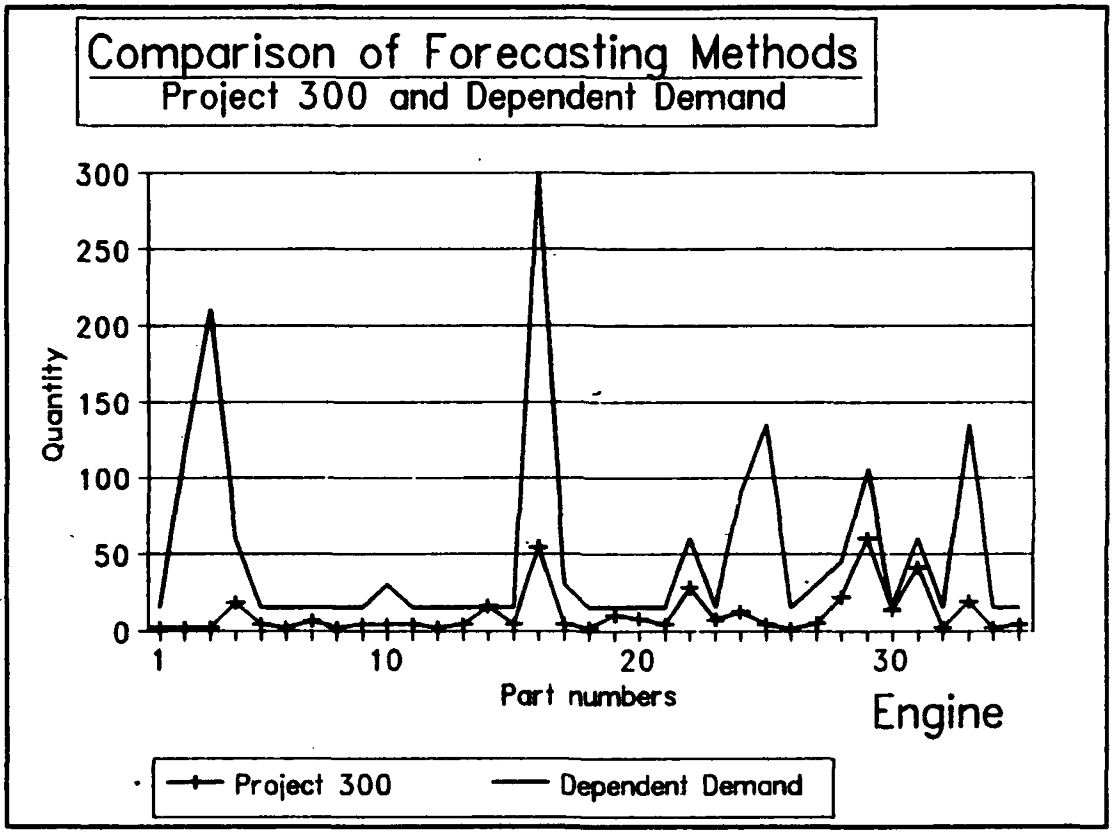

Figure 8. Comparison of Forecasting Methods (Engine). Annual Fleet Effort 800 Hours per Aircraft

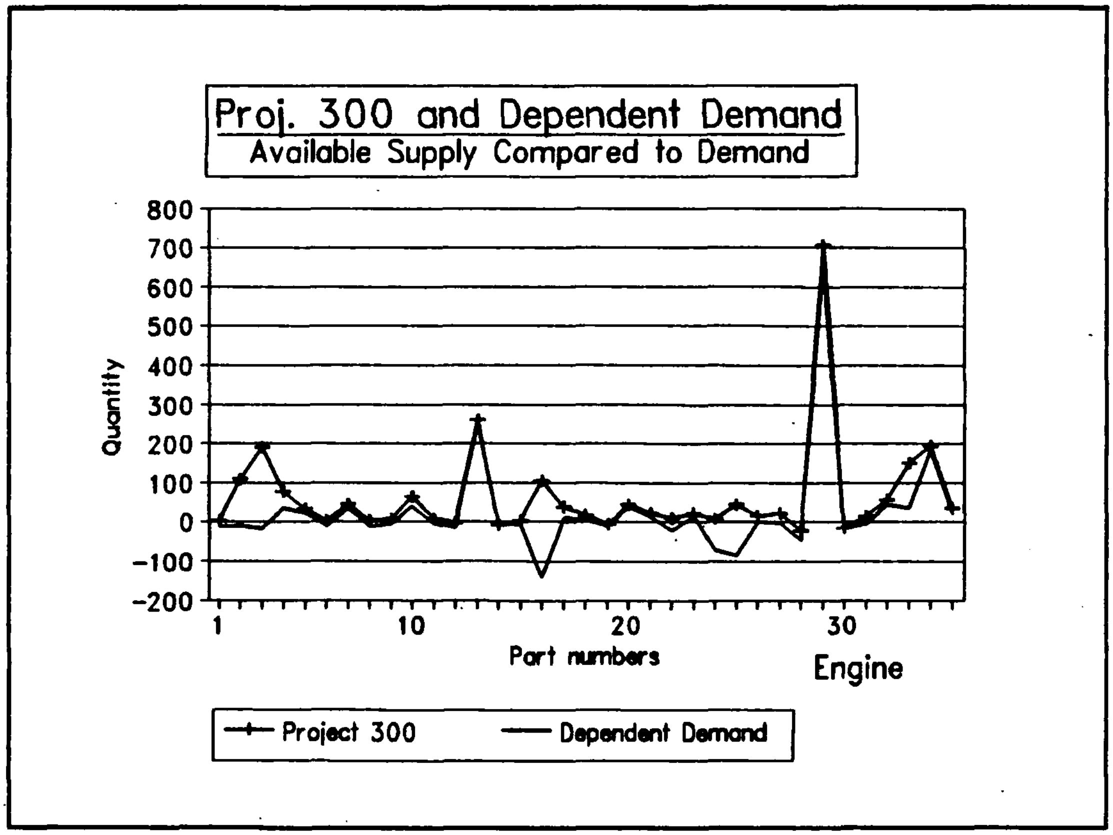

Figure 9. Available Supply Compared to Demand (Engine). Annual Fleet Effort 800 Hours per Aircraft

Appendix M: Comparison of Forecasts for the Propellers Shop, Fleet Effort 800 Hours per Aircraft per Year

Report 1 Name: Propeller PN: 54H60-117 Page 1
Fleet Effort: 800 Hours/Aircraft/year Date 06/20/91
Propellers Needed: 18 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand Forecast

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
01-10907	10	40	30	18	22
01-10939	28	46	18	18	28
296-19	16	28	12	36	-8
321319	127	268	141	72	196
322207-14S	2	76	74	18	58
507311-15	10	10		18	-8
509927	20	104	84	90	14
510230	6	10	4	18	-8
510231	4	19	15	18	1
510233	22	56	34	18	38
510234	5	9	4	18	-9
510239	4	16	12	18	-2
511558	11	18	7	18	
513681	13	39	26	18	21
513704	40	156	116	72	84
514287	10	20	10	18	2
514288	10	27	17	18	9
514796-1	4	42	38	36	6
514813	2	6	4	18	-12
514828-2	6	9	3	18	-9
520007	32	415	383	144	271
52479	73	124	51	18	106
525354	100	628	528	144	484
525644	34	90	56	18	72
527102	80	280	200	72	208
527124	25	12	-13	18	-6
536443	2	6	4	18	-12
536445	10	22	12	18	4
537297	2	4	2	18	-14
537819	14		-14	18	-18
539841	24	36	12	18	18
540346	11	27	16	36	-9
541017	150	690	540	540	150
541888	20	46	26	18	28
546385	20	34	14	18	16
546415	22	32	10	18	14
546569B	4	6	2	18	-12
547835	4	8	4	18	-10
547843	4	6	2	18	-12

Report 1 Name: Propeller PN: 54H60-117 Page 2
Fleet Effort: 800 Hours/Aircraft/year Date 06/20/91
Propellers Needed: 18 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand Forecast

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
548886	35	75	40	54	21
554861	43	60	17	36	24
557011	10	18	8	18	
560768	20	40	20	18	22
560773	14	19	5	18	1
59723	83	191	108	54	137
69483G139-4359	13		-13	36	-36
69494R113	59	372	313	72	300
69494R117	10	102	92	72	30
69494R137	44	424	380	108	316
69494R250	43	48	5	18	30
69494R443	10	53	43	18	35
69494R9	7	136	129	18	118
69670-18-0	14	33	19	18	15
69917-062M375S	25	55	30	18	37
69923C4	40	47	7	36	11
69994P3-3C	28	96	68	108	-12
726667-1	18	48	30	18	30
726681-1	20	46	26	18	28
737191-1	10	34	24	18	16
740313-3	10	9	-1	18	-9
7987IMA018	68	2	-66	18	-16
AN106512	46	108	62	90	18
AN106516	101	585	484	90	495
AN148662	96	105	9	72	33
AN148865	74	102	28	144	-42
AN315-8R	34	1262	1228	18	1244
AN381-4-20	138	980	842		980
AN960-416L	76	113	37	72	41
AN960-716	70	265	195	18	247
DCN4-4423	120	55	-65	36	19
M83248-2-117	96	161	65	72	89
MS16562-190	103	150	47	18	132
MS21044N4	13	97	84	90	7
MS24665-132	900	1154	254	90	1064
MS24665-281	22	771	749	18	753
MS24665-285	36	192	156	144	48
MS24665-88	618	895	277	54	841

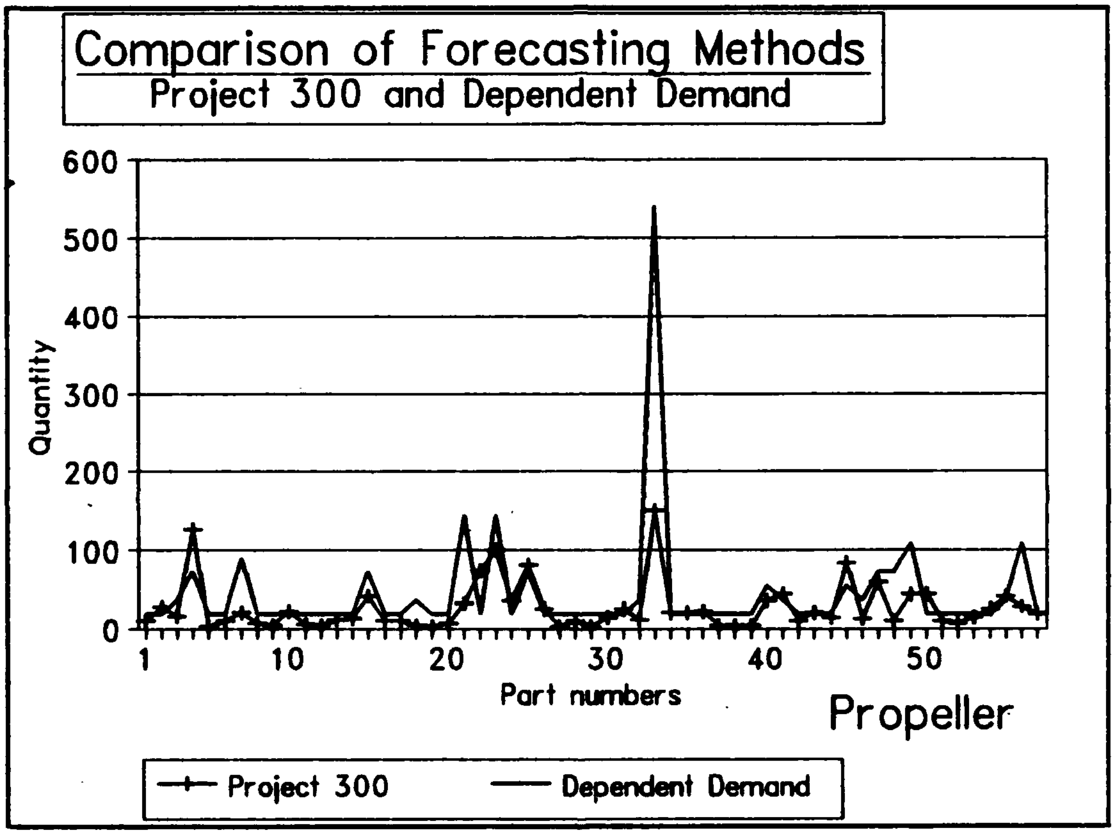

Figure 10. Comparison of Forecasting Methods (Propeller). Annual Fleet Effort 800 Hours per Aircraft

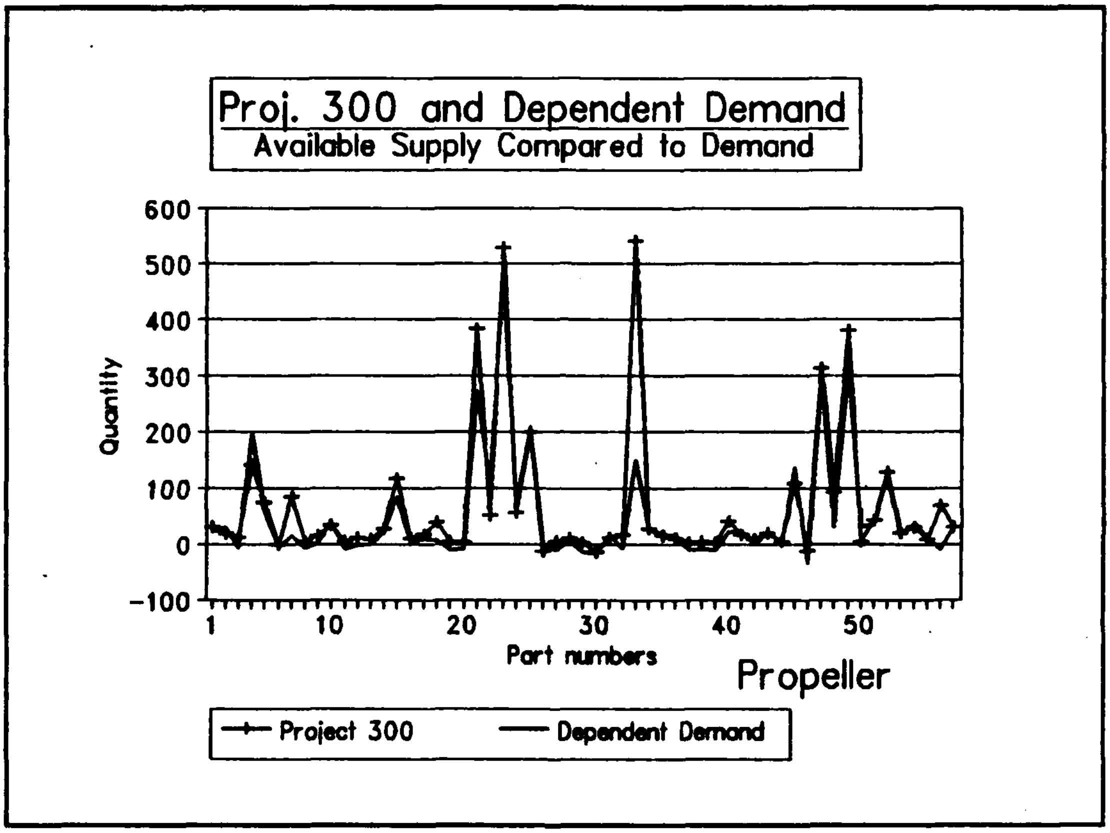

Figure 11. Available Supply Compared to Demand (Propeller). Annual Fleet Effort 800 Hours per Aircraft

Appendix N: Comparison of Forecasts for the Engines Shop, Fleet Effort 900 Hours per Aircraft per Year

Report 1 Name: Engine PN: T56A15 Page 1
Fleet Effort: 900 Hours/Aircraft/year Date 06/20/91
Engines Needed: 16 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
115458	2	4	2	16	-12
180886	2	111	109	128	-17
181398	2	193	191	224	-31
181481	18	94	76	64	30
181829	4	37	33	16	21
181898	2	5	3	16	-11
187417	6	50	44	16	34
189153	2	4	2	16	-12
189156	4	12	8	16	-4
189328	4	70	66	32	38
189334	4	11	7	16	-5
189758	2	1	-1	16	-15
192462	4	266	262	16	250
2660351	16	10	-6	16	-6
557S16	4	8	4	16	-8
6739865	54	158	104	320	-162
6788286	4	41	37	32	9
6793461	2	20	18	16	4
6816058-2	10	6	-4	16	-10
6846212	8	54	46	16	38
6849497	4	28	24	16	12
6859086	28	38	10	64	-26
6870042	7	30	23	16	14
6878485	12	20	8	96	-76
7006603	4	49	45	144	-95
7006737	1	16	15	16	
AM33K5E5823A	5	28	23	32	-4
AMS1K7E5823A	22		-22	48	-48
AN960-8	60	765	705	112	653
AS3085-161	14		-14	16	-16
MS21083N4	41	57	16	64	-7
MS3102R12S3P	2	59	57	16	43
MS9020-10	19	171	152	144	27
MS9089-18	2	198	196	16	182
RR106S	4	38	34	16	22

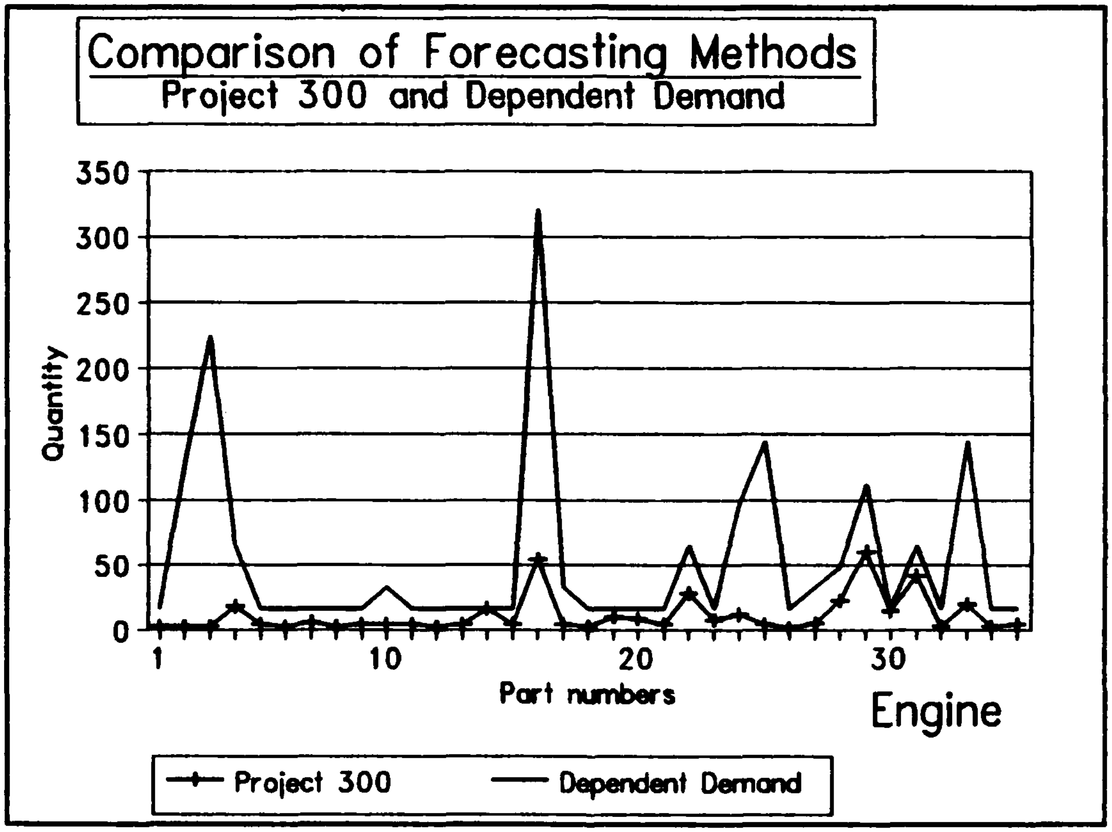

Figure 12. Comparison of Forecasting Methods (Engine). Annual Fleet Effort 900 Hours per Aircraft

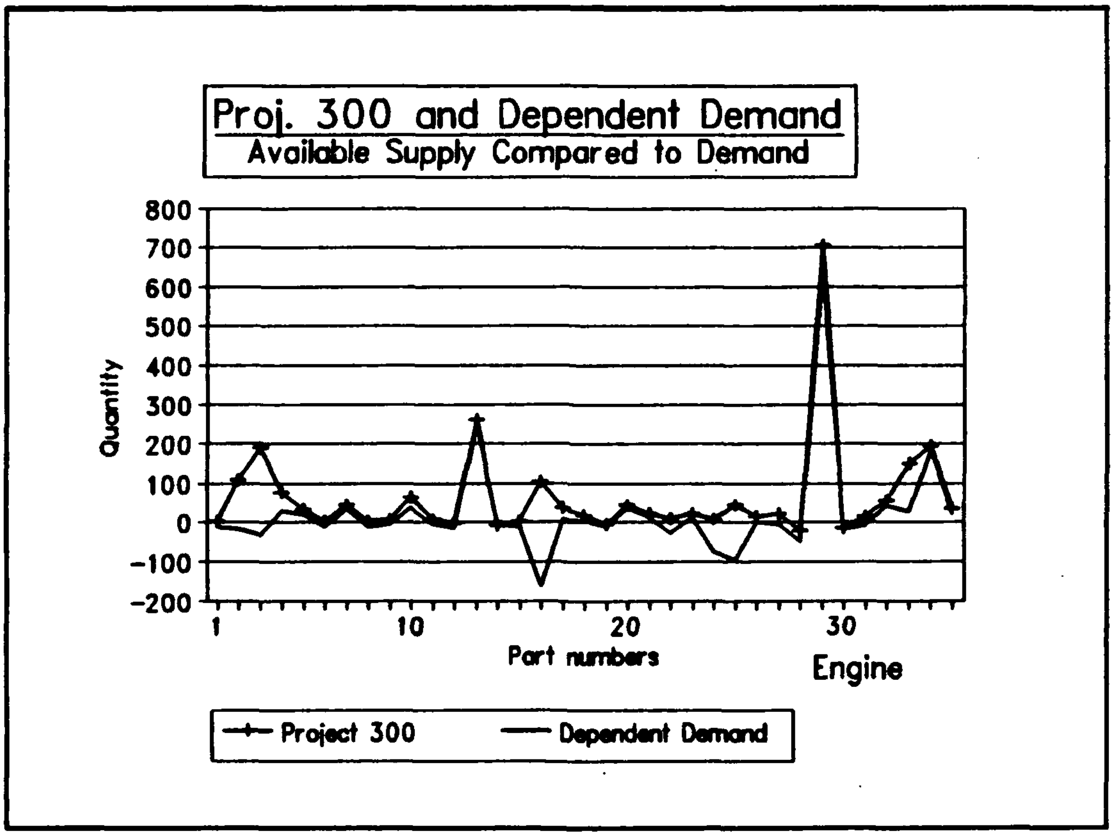

Figure 13. Available Supply Compared to Demand (Engine). Annual Fleet Effort 900 Hours per Aircraft

Appendix O: Comparison of Forecasts for the Propellers Shop, Fleet Effort 900 Hours per Aircraft per Year

Report 1 Name: Propeller PN: 54H60-117 Page 1
Fleet Effort: 900 Hours/Aircraft/year Date 06/20/91
Propellers Needed: 20 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand Forecast

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
01-10907	10	40	30	20	20
01-10939	28	46	18	20	26
296-19	16	28	12	40	-12
321319	127	268	141	80	188
322207-14S	2	76	74	20	56
507311-15	10	10		20	-10
509927	20	104	84	100	4
510230	6	10	4	20	-10
510231	4	19	15	20	-1
510233	22	56	34	20	36
510234	5	9	4	20	-11
510239	4	16	12	20	-4
511558	11	18	7	20	-2
513681	13	39	26	20	19
513704	40	156	116	80	76
514287	10	20	10	20	
514288	10	27	17	20	7
514796-1	4	42	38	40	2
514813	2	6	4	20	-14
514828-2	6	9	3	20	-11
520007	32	415	383	160	255
52479	73	124	51	20	104
525354	100	628	528	160	468
525644	34	90	56	20	70
527102	80	280	200	80	200
527124	25	12	-13	20	-8
536443	2	6	4	20	-14
536445	10	22	12	20	2
537297	2	4	2	20	-16
537819	14		-14	20	-20
539841	24	36	12	20	16
540346	11	27	16	40	-13
541017	150	690	540	600	90
541888	20	46	26	20	26
546385	20	34	14	20	14
546415	22	32	10	20	12
546569B	4	6	2	20	-14
547835	4	8	4	20	-12
547843	4	6	2	20	-14

Report 1 Name: Propeller PN: 54H60-117 Page 2
Fleet Effort: 900 Hours/Aircraft/year Date 06/20/91
Propellers Needed: 20 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand Forecast

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
548886	35	75	40	60	15
554861	43	60	17	40	20
557011	10	18	8	20	-2
560768	20	40	20	20	20
560773	14	19	5	20	-1
59723	83	191	108	60	131
69483G139-4359	13		-13	40	-40
69494R113	59	372	313	80	292
69494R117	10	102	92	80	22
69494R137	44	424	380	120	304
69494R250	43	48	5	20	28
69494R443	10	53	43	20	33
69494R9	7	136	129	20	116
69670-18-0	14	33	19	20	13
69917-062M375S	25	55	30	20	35
69923C4	40	47	7	40	7
69994P3-3C	28	96	68	120	-24
726667-1	18	48	30	20	28
726681-1	20	46	26	20	26
737191-1	10	34	24	20	14
740313-3	10	9	-1	20	-11
7987IMA018	68	2	-66	20	-18
AN106512	46	108	62	100	8
AN106516	101	585	484	100	485
AN148662	96	105	9	80	25
AN148865	74	102	28	160	-58
AN315-8R	34	1262	1228	20	1242
AN381-4-20	138	980	842		980
AN960-416L	76	113	37	80	33
AN960-716	70	265	195	20	245
DCN4-4423	120	55	-65	40	15
M83248-2-117	96	161	65	80	81
MS16562-190	103	150	47	20	130
MS21044N4	13	97	84	100	-3
MS24665-132	900	1154	254	100	1054
MS24665-281	22	771	749	20	751
MS24665-285	36	192	156	160	32
MS24665-88	618	895	277	60	835

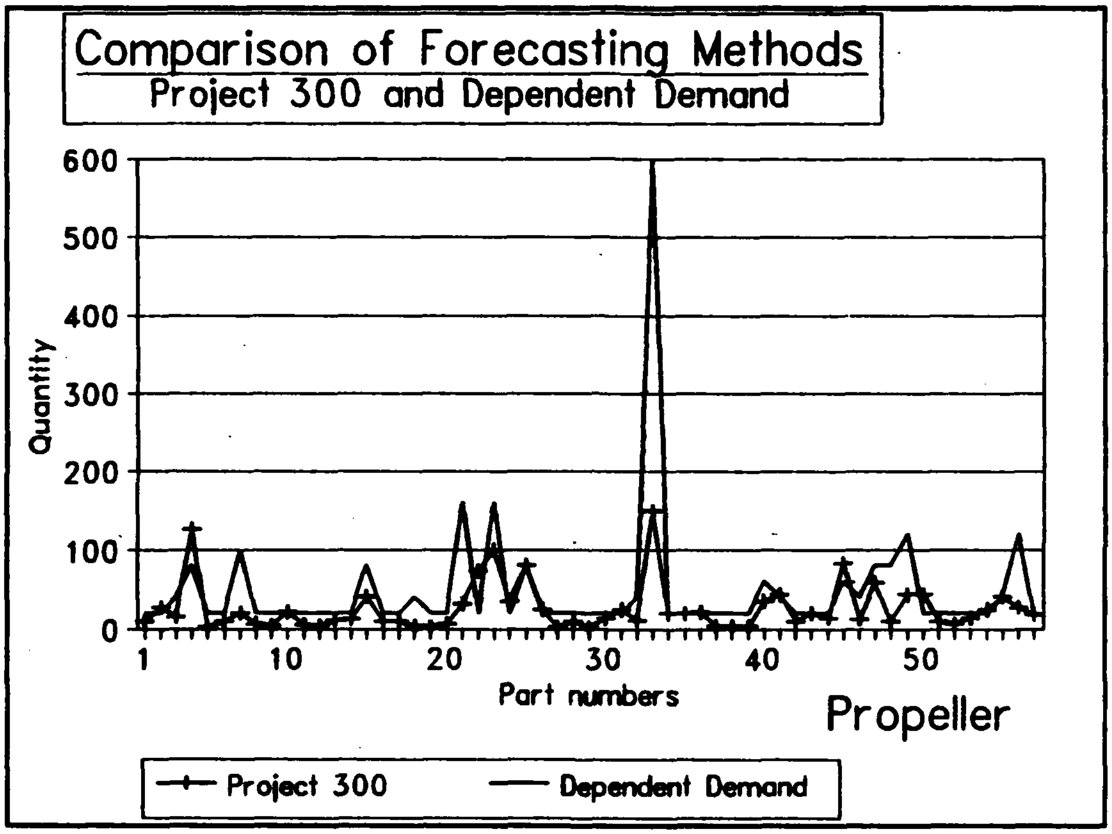

Figure 14. Comparison of Forecasting Methods (Propeller). Annual Fleet Effort 900 Hours per Aircraft

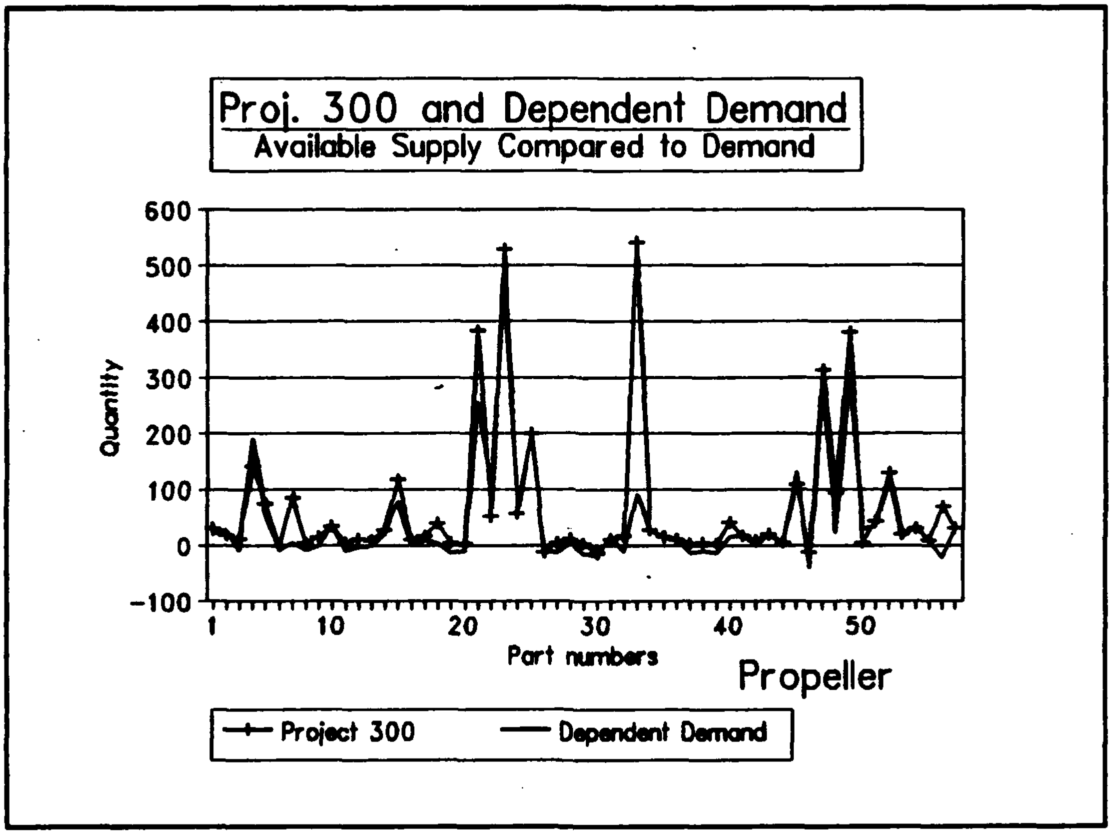

Figure 15. Available Supply Compared to Demand (Propeller). Annual Fleet Effort 900 Hours per Aircraft

Appendix P: Comparison of Forecasts for the Engines Shop, Fleet Effort 1000 Hours per Aircraft per Year

Report 1 Name: Engine PN: T56A15 Page 1
Fleet Effort: 1000 Hours/Aircraft/year Date 06/20/91
Engines Needed: 18 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
115458	2	4	2	18	-14
180886	2	111	109	144	-33
181398	2	193	191	252	-59
181481	18	94	76	72	22
181829	4	37	33	18	19
181898	2	5	3	18	-13
187417	6	50	44	18	32
189153	2	4	2	18	-14
189156	4	12	8	18	-6
189328	4	70	66	36	34
189334	4	11	7	18	-7
189758	2	1	-1	18	-17
192462	4	266	262	18	248
2660351	16	10	-6	18	-8
557S16	4	8	4	18	-10
6739865	54	158	104	360	-202
6788286	4	41	37	36	5
6793461	2	20	18	18	2
6816058-2	10	6	-4	18	-12
6846212	8	54	46	18	36
6849497	4	28	24	18	10
6859086	28	38	10	72	-34
6870042	7	30	23	18	12
6878485	12	20	8	108	-88
7006603	4	49	45	162	-113
7006737	1	16	15	18	-2
AM33K5E5823A	5	28	23	36	-8
AMS1K7E5823A	22		-22	54	-54
AN960-8	60	765	705	126	639
AS3085-161	14		-14	18	-18
MS21083N4	41	57	16	72	-15
MS3102R12S3P	2	59	57	18	41
MS4MS9020-10	19	171	152	162	9
MS9089-18	2	198	196	18	180
RR106S	4	38	34	18	20

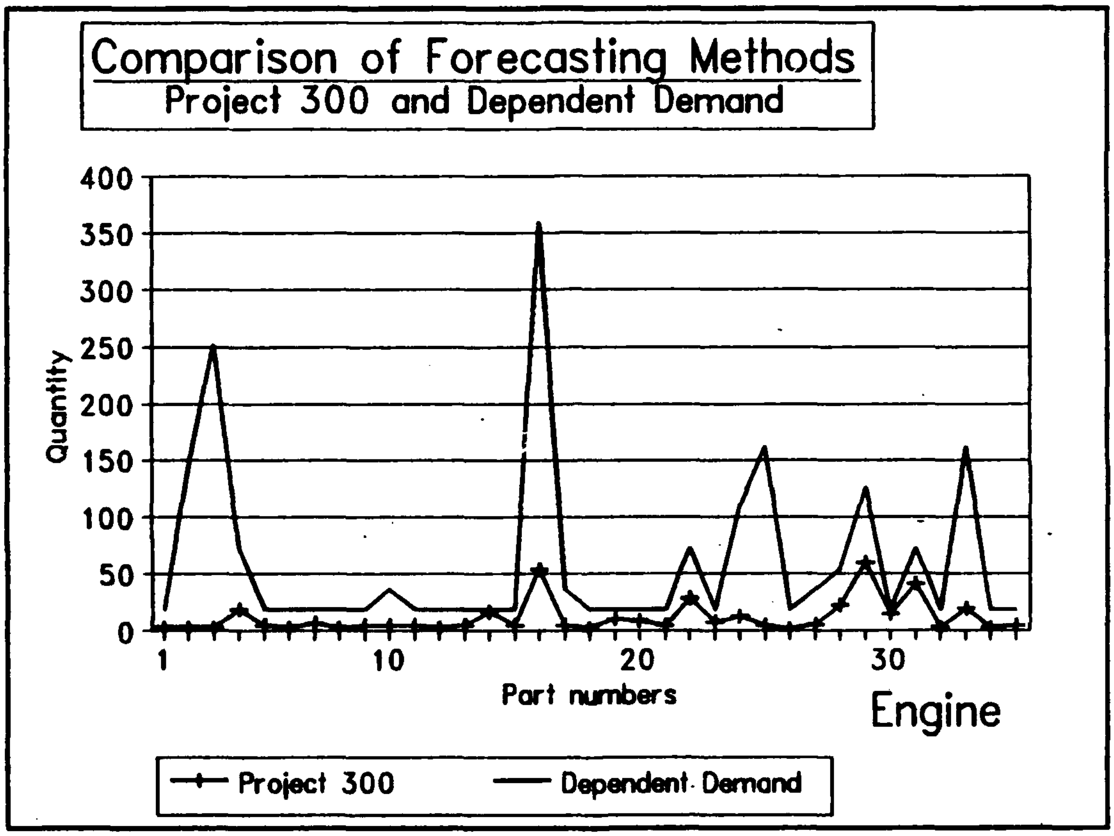

Figure 16. Comparison of Forecasting Methods (Engine). Annual Fleet Effort 1000 Hours per Aircraft

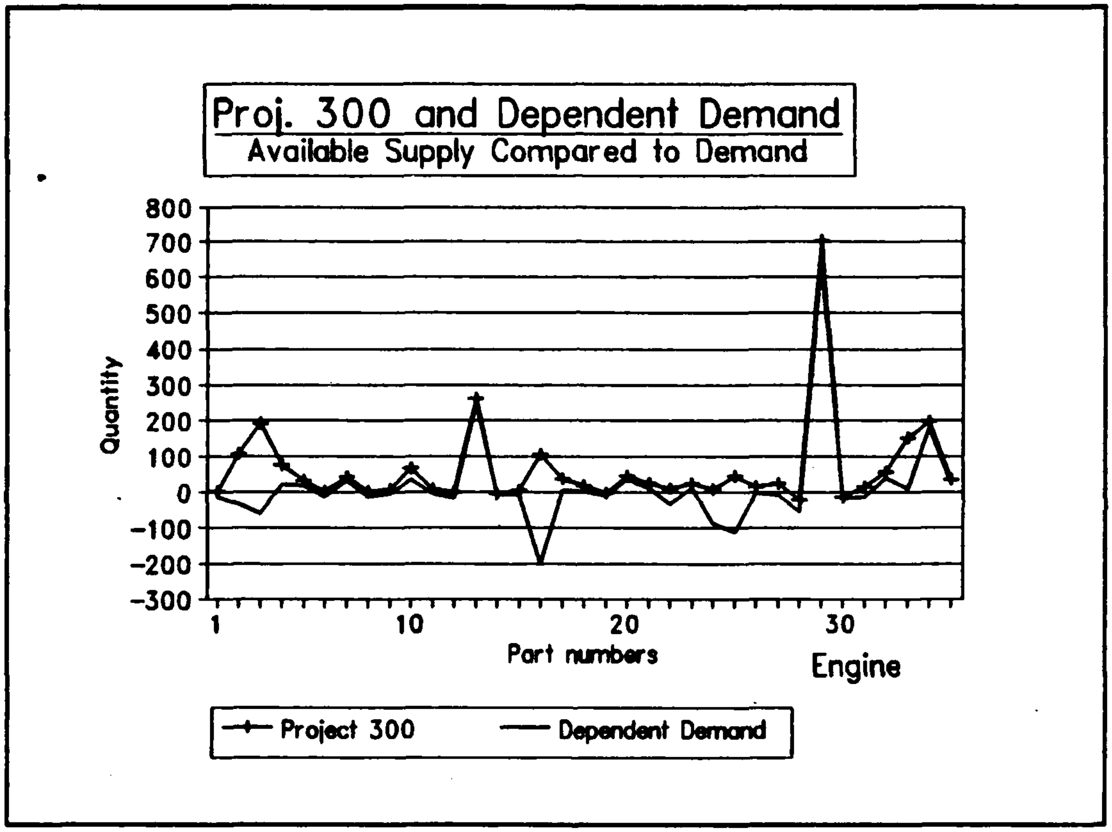

Figure 17. Available Supply Compared to Demand (Engine). Annual Fleet Effort 1000 Hours per Aircraft

Appendix Q: Comparison of Forecasts for the Propellers Shop, Fleet Effort 1000 Hours per Aircraft per Year

Report 1 Name: Propeller PN: 54H60-117 Page 1
Fleet Effort: 1000 Hours/Aircraft/year Date 06/20/91
Propellers Needed: 22 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand Forecast

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
01-10907	10	40	30	22	18
01-10939	28	46	18	22	24
296-19	16	28	12	44	-16
321319	127	268	141	88	180
322207-14S	2	76	74	22	54
507311-15	10	10		22	-12
509927	20	104	84	110	-6
510230	6	10	4	22	-12
510231	4	19	15	22	-3
510233	22	56	34	22	34
510234	5	9	4	22	-13
510239	4	16	12	22	-6
511558	11	18	7	22	-4
513681	13	39	26	22	17
513704	40	156	116	88	68
514287	10	20	10	22	-2
514288	10	27	17	22	5
514796-1	4	42	38	44	-2
514813	2	6	4	22	-16
514828-2	6	9	3	22	-13
520007	32	415	383	176	239
52479	73	124	51	22	102
525354	100	628	528	176	452
525644	34	90	56	22	68
527102	80	280	200	88	192
527124	25	12	-13	22	-10
536443	2	6	4	22	-16
536445	10	22	12	22	
537297	2	4	2	22	-18
537819	14		-14	22	-22
539841	24	36	12	22	14
540346	11	27	16	44	-17
541017	150	690	540	660	30
541888	20	46	26	22	24
546385	20	34	14	22	12
546415	22	32	10	22	10
546569B	4	6	2	22	-16
547835	4	8	4	22	-14
547843	4	6	2	22	-16

Report 1 Name: Propeller PN: 54H60-117 Page 2
Fleet Effort: 1000 Hours/Aircraft/year Date 06/20/91
Propellers Needed: 22 List of Spare Parts
Project 300 Forecast Compared to Dependent Demand Forecast

Part Number	P 300 Forecast	Material Available	Balance	Dependent Demand	Balance
548886	35	75	40	66	9
554861	43	60	17	44	16
557011	10	18	8	22	-4
560768	20	40	20	22	18
560773	14	19	5	22	-3
59723	83	191	108	66	125
69483G139-4359	13		-13	44	-44
69494R113	59	372	313	88	284
69494R117	10	102	92	88	14
69494R137	44	424	380	132	292
69494R250	43	48	5	22	26
69494R443	10	53	43	22	31
69494R9	7	136	129	22	114
69670-18-0	14	33	19	22	11
69917-062M375S	25	55	30	22	33
69923C4	40	47	7	44	3
69994P3-3C	28	96	68	132	-36
726667-1	18	48	30	22	26
726681-1	20	46	26	22	24
737191-1	10	34	24	22	12
740313-3	10	9	-1	22	-13
7987IMA018	68	2	-66	22	-20
AN106512	46	108	62	110	-2
AN106516	101	585	484	110	475
AN148662	96	105	9	88	17
AN148865	74	102	28	176	-74
AN315-8R	34	1262	1228	22	1240
AN381-4-20	138	980	842		980
AN960-416L	76	113	37	88	25
AN960-716	70	265	195	22	243
DCN4-4423	120	55	-65	44	11
M83248-2-117	96	161	65	88	73
MS16562-190	103	150	47	22	128
MS21044N4	13	97	84	110	-13
MS24665-132	900	1154	254	110	1044
MS24665-281	22	771	749	22	749
MS24665-285	36	192	156	176	16
MS24665-88	618	895	277	66	829

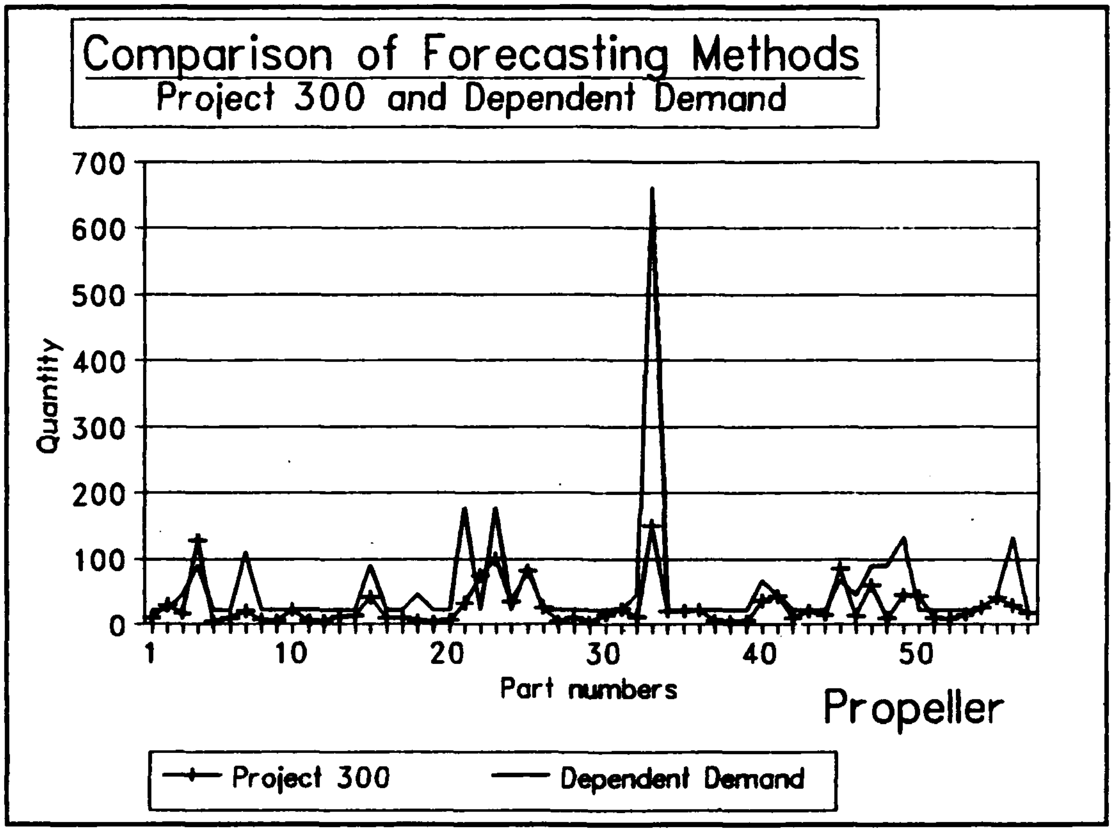

Figure 18. Comparison of Forecasting Methods (Propeller). Annual Fleet Effort 1000 Hours per Aircraft

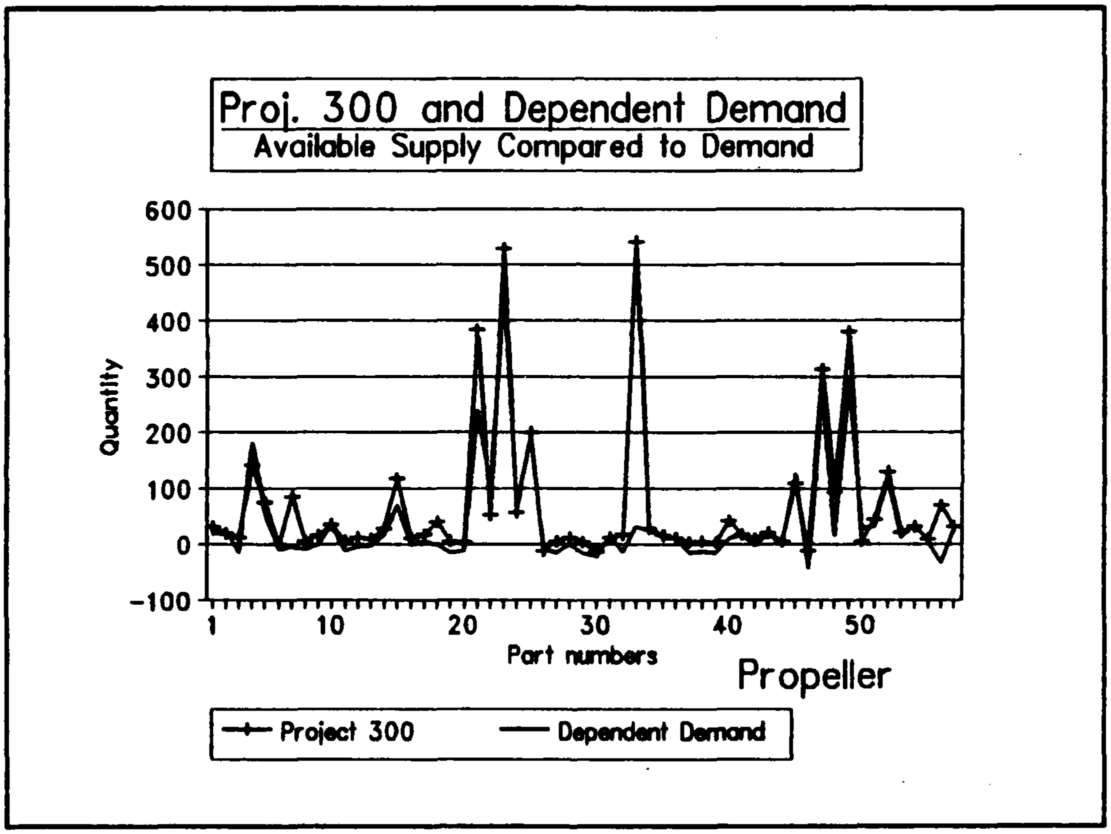

Figure 19. Available Supply Compared to Demand (Propeller). Annual Fleet Effort 1000 Hours per Aircraft

Appendix R: Glossary of Acronyms

AFIT	- Air Force Institute of Technology
AFLC	- Air Force Logistics Command
AMC	- Average monthly consumption
BAF	- Brazilian Air Force
CAGE	- Commercial and Government Entity
DBASE III	- Software DBase III
DBF	- Data base file
DMMIS	- Depot Maintenance Management Information System
DOD	- Department of Defense
H4	- DOD H4 series technical publications
IBM	- International Business Machines Inc.
IMA	- Instrução do Ministério da Aeronáutica (Brazilian Air Force Instruction)
JIT	- Just in time
MBM	- Modular bill of materials
MICAP	- Mission capability
MFR	- Manufacturer
MMA	- Manual do Ministério da Aeronáutica (Brazilian Air Force Manual)
MPS	- Master production schedule
MRP	- Materials requirements planning
MTBF	- Mean time between failures
NHA	- Next higher assembly
NSN	- National stock number

PN	- Part number
QUATTRO PRO	- Software QUATTRO PRO
RDB	- Requirements data bank
USAF	- United States Air Force
VS1	- Virtual system 1 (IBM)

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Vita

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13. ABSTRACT *(Maximum 200 words)* The first objective of this study was to identify all the common supply items currently managed separately in the inventory of the various types of aircraft employed by the Brazilian Air Force, and to show how the system could be reorganized to consider the compatibility among these items. DBase III programs were used to examine a file with 30103 registers containing part numbers occurring more than once in different aircraft's inventory, and to classify them in groups of identical items likely to be centrally managed. In addition it was demonstrated that the system's structure would support the proposed reorganization without deep changes. The second issue in this thesis was the appropriateness of creating a system based on the dependent demand concept, that would enable the depots to predict the consumable items necessary to carry out their maintenance tasks with more accuracy. A conceptual program in QUATTRO PRO, which uses basic principles that would apply in the development of such a system, was written to show that the information necessary to create the proposed system is already available, and to show its usefulness for the depots.

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